

## Grade 10 Science, Academic (SNC2D): Light and Geometric Optics Unit Plan

Day	Topic	Activities	Resources
1	<b>Human Eye</b>  Describe the different parts of the eye and how the eye functions.  Start assignment on a technological device or procedure related to human perception of light.	Activity 1: locating your blind spot OR Activity 2: Disappearing Finger  Word Sort: Students are given a set of words which they must organize in a logical manner and brainstorm as many ideas as possible about each given word.  Teacher will give a brief presentation about how the eye functions and explain the blind spot.  Using a RAFT students will analyse a technological device or procedure related to human perception of light (e.g., eyeglasses, contact lenses, infrared or low light vision sensors, laser surgery), and evaluate its effectiveness.  This activity will be due towards the end of the unit so that students may incorporate the knowledge they acquire throughout the unit.	appendix 1.1 *ONS10 pg 485  human eye info ONS10 pg 506-510 **SP10 pg 572-579  <b>overall expectations:</b> A1, E1 <b>specific expectations</b> A1.3, A1.7, A1.10, A1.12, A1.13, E1.1
2	<b>What is Light?</b> <ul style="list-style-type: none"> <li>▪ How is light produced?</li> <li>▪ properties of light</li> <li>▪ E&amp;M spectrum</li> <li>▪ colours</li> </ul>	<ul style="list-style-type: none"> <li>▪ Assess students' knowledge of light and mirrors.</li> <li>▪ Demo: dispersion of light using triangular prism</li> <li>▪ Glowing Slime Lab</li> </ul>	SP10 pg 461, 467  ONS10 pg 401 <b>overall expectations:</b> E3 <b>specific expectations</b> E3.2

3	<b>Sources of Light</b> chemiluminescence, bioluminescence, incandescence, fluorescence, phosphorescence, triboluminescence; from an electric discharge or light-emitting diode (LED), Laser	<ul style="list-style-type: none"> <li>Demo: glow sticks</li> <li>Activity: eating wintergreen candy to observe triboluminescence (or duct tape)</li> </ul>	glow sticks, sugar cubes, wintergreen candy SP10 pg474-475  <i><b>overall expectations:</b></i> E3 <i><b>specific expectations</b></i> E3.1
4	<b>Plane Mirror Reflection</b>	<p>In small groups, students will be provided with a diagram and terminology used in plane mirror reflection. They will be asked to match the terms to the correct places on the diagram.</p> <p>Once they have learned the terminology, student's will be broken up according to their learning styles and complete one the activities:</p> <ul style="list-style-type: none"> <li>Option 1: Light Reflecting Off a Plane Mirror Activity</li> <li>Option 2: Reflection Obstacle Course (for students who already grasp the laws of reflection)</li> <li>Option 3: Read textbook section and answer questions.</li> <li>Option 4: Access website with applet</li> </ul> <p>Teacher will lead a class discussion to ensure that all students were successful in discovering that the angle of incidence is equal to the angle of reflection. Homework questions from the textbook may be assigned to class at the end of the period.</p>	SP10 pg 483 ONS10 pg413  <i><b>overall expectations:</b></i> A1, E2, E3 <i><b>specific expectations</b></i> A1.5, A1.6, A1.10, A1.12, E2.1, E2.2, E3.8

5	<b>Laws of Reflection</b> <ul style="list-style-type: none"> <li>Review findings from previous activity: <math>\theta_i = \theta_r</math></li> <li>Drawing ray diagrams to locate image in the mirror</li> <li>Image characteristics (SALT)</li> <li>Real vs Virtual Image</li> </ul>	Students perform a guided inquiry lab to discover how an image can be located in a plane mirror.	***S9 pg 236  <b>overall expectations:</b> A1, E2, E3 <b>specific expectations</b> A1.8, A1.10, E2.1, E2.2, E2.3, E3.3
6-8	<b>Convex , Concave and Curved Mirrors</b> <ul style="list-style-type: none"> <li>Images and applications</li> </ul>	<ul style="list-style-type: none"> <li>Use the Smarter Science Framework and “Steps to Inquiry” Posters to have students explore mirrors through inquiry (see: <a href="http://dpcdsb-ssc.wikispaces.com/Smarter+Science">http://dpcdsb-ssc.wikispaces.com/Smarter+Science</a>)</li> <li>Through consolidation:               <ul style="list-style-type: none"> <li>Introduce Terminology of Convex and Concave Mirrors</li> <li>Ray diagrams</li> </ul> </li> </ul>	S9 pg 242, 244 SP10 pg 502  <b>overall expectations:</b> A1, E2 <b>specific expectations</b> A1.1-1.11 (dependent on focus area of inquiry); E2.1, E2.2, E2.3, E2.5, E3.3
9	<b>Introduction to Refraction</b> Students plan and perform an experiment which allows them to learn the following: <ul style="list-style-type: none"> <li>What is refraction?</li> <li>Refraction terminology</li> <li>Rules of Refraction</li> <li>Conditions for refraction</li> <li>Relationship between the angle of incidence and the angle of refraction</li> </ul>	<b>Day 1</b> <ul style="list-style-type: none"> <li>Assess students’ knowledge of refraction</li> <li>Activity: Try This- Exploring with Light</li> <li>Activity: The Re-appearing Coin</li> <li>Teacher Demo: Proper use of ray box , polar coordinate paper and semicircular dishes</li> <li>Word Match: In small groups, students will be provided with a diagram and terminology used in plane mirror reflection. They will be asked to match the terms to the correct places on the diagram.</li> <li>Students plan an experiment to explore the path of light as it travels from one medium to another and compare the angle of incidence to</li> </ul>	SP10 pg 513 SP10 pg 515 ONS10 pg447 <b>overall expectations:</b> A1, E2, E3 <b>specific expectations</b> A1.1, A1.2, A1.4, A1.5, A1.8, A1.10, A1.11, A1.12, A1.13, E2.1, E2.4, E3.7, E3.8

		<p>the angle of refraction. <b>Note: This could be done using the Smarter Science Framework &amp; Posters (see: <a href="http://dpcdsb-ssc.wikispaces.com/Smarter+Science">http://dpcdsb-ssc.wikispaces.com/Smarter+Science</a>)</b></p> <p><b>Day 2</b></p> <ul style="list-style-type: none"> <li>▪ Students perform their experiment, record observations and results.</li> <li>▪ Students answer questions based on the experiment and formulate a conclusion.</li> <li>▪ Students participate in a teacher-led discussion.</li> <li>▪ Students complete an Exit Card and perform a Marching Soldier Activity.</li> </ul>	
10	<b>Refraction of Light Through Different Media</b>	Students observe how different media affect the path of the ray of light and the amount of refraction.	<p>SP10 pg 522-523</p> <p><b>overall expectations:</b> E2</p> <p><b>specific expectations</b> E2.1, E2.4, E3.4, E3.7</p>
11	<b>Index of Refraction</b> <ul style="list-style-type: none"> <li>▪ Definition</li> <li>▪ Solving problems using <math>n=c/v</math></li> </ul>		<p><b>overall expectations:</b> E3</p> <p><b>specific expectations</b> E2.1, E2.6, E3.7</p>
12	<b>LAB: Snell's Law</b>	<p>LAB: Refraction of Light from Air into Plexi-Glass and from Plexi-Glass to Air</p> <p>(Student's will discover the ratio but you can show them Snell's Equation if you have a strong class.)</p>	<p>SP10 pg 520</p> <p><b>overall expectations:</b> E2</p> <p><b>specific expectations</b> E2.1, E2.4, E3.4, E3.7</p>
13	<b>Phenomena Related to Refraction</b>	<ul style="list-style-type: none"> <li>▪ Explain various phenomena</li> <li>▪ Activity: Apparent Depth</li> </ul>	<p>ONS10 pg471</p> <p><b>overall expectations:</b> E3</p> <p><b>specific expectations</b> E2.1, E3.8</p>

14	<b>Total Internal Reflection</b> <ul style="list-style-type: none"> <li>Definition</li> <li>Critical angle</li> <li>Application of TIR</li> </ul>	<ul style="list-style-type: none"> <li>Students' should have discovered TIR in previous lab.</li> <li>Demo: ray box and plexi-glass</li> <li>Activity option 1: Fountain of Light</li> <li>Activity option 2: Measuring the Critical Angle of Various Media</li> </ul>	ONS10 pg 463 SP10 pg 532 <b>overall expectations:</b> E2 <b>specific expectations</b> E2.1, E3.8, E3.4
15	<b>Introduction to Lenses</b> <ul style="list-style-type: none"> <li>Terminology</li> <li>Ray diagrams</li> </ul>	<ul style="list-style-type: none"> <li>Assess students' knowledge of lenses</li> <li>Demo: optical lab bench showing a real vs virtual image</li> </ul>	SP10 pg 549 <b>overall expectations:</b> E3 <b>specific expectations</b> E2.1, E2.5, E3.5
16	<b>LAB: Thin Lens</b>	Students discover thin lens equation by performing the lab.	SP10 pg554 <b>overall expectations:</b> E2 <b>specific expectations</b> E2.1, E2.5, E3.5
17	<b>Thin Lens Equation</b>	Solve problems using Thin Lens Equation	<b>overall expectations:</b> E3 <b>specific expectations</b> E2.1, E2.5, E3.5
18	<b>Lens and Mirror Applications</b> Students learn about different applications of lenses and mirrors.	<ul style="list-style-type: none"> <li>Students brainstorm about how different devices function using a placemat graphic organizer.</li> <li>Students analyse three optical devices by either researching the textbook, using online resources or taking the devices apart.</li> <li>Students present their findings on the following day and complete an Exit Card.</li> </ul>	<b>overall expectations:</b> E1, E3 <b>specific expectations</b> E1.1, E2.1, E3.6
19	<b>REVIEW</b>	<p><b>*ONS10:</b> Adam-Carr, Christine, et al. (2010) <u>Science Perspectives 10</u>. Toronto: Nelson Education Ltd.</p> <p><b>**SP:</b> Dickinson, Tom et al. (2009) <u>ON Science 10</u>. Toronto, ON: McGraw-Hill Ryerson Limited. Science 9. Toronto, ON: Nelson Canada, 1995.</p> <p><b>***S9:</b> Ritter, Bob et al. (1995) <u>Science 9</u>. Scarborough, ON: Nelson Canada.</p>	
20	<b>UNIT TEST</b>		

## Grade 10 Science, Academic (SNC2D): Light and Geometric Optics

### Lesson 1/The Human Eye: An Introduction to Optics

**Duration:** one 75 minute period + periodical checks on student progress throughout unit

Key Instructional Strategies		Differentiated Instruction Details
1	Think-Pair-Share: Blind Spot Testers (Cooperative Learning)*	<b>Knowledge of Students</b> Differentiation based on student: <input type="checkbox"/> Readiness <input checked="" type="checkbox"/> Interest <input checked="" type="checkbox"/> Preferences <b>Differentiated Instruction Response</b> <input type="checkbox"/> Learning materials (content) <input type="checkbox"/> Ways of learning (process) <input checked="" type="checkbox"/> Ways of demonstrating learning (product) <input type="checkbox"/> Learning environment
2	Word Sort	
3	Whole Class Discussion: The Human Eye (Questions and Cues)*	
4	Brainstorming	
5	RAFT**: Technological Devices and Procedures	
6	Product Choice Reflection (Setting Objectives and Providing Feedback)*	

\*Marzano's Categories of Instructional Strategies    \*\*Differentiated Instruction Structure

### Curriculum Connections

#### Overall Expectation(s):

A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating);

E1. evaluate the effectiveness of technological devices and procedures designed to make use of light, and assess their social benefits

#### Specific Expectation(s):

A1.3 identify and locate print, electronic, and human sources that are relevant to research questions

A1.7 select, organize, and record relevant information on research topics from various sources, including electronic, print, and/or human sources (e.g., websites for public health organizations, federal and provincial government publications, reference books, personal interviews), using recommended formats and an accepted form of academic documentation

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

A1.12 use appropriate numeric, symbolic, and graphic modes of representation, and appropriate units of measurement (e.g., SI and imperial units)

A1.13 express the results of any calculations involving data accurately and precisely

E1.1 analyse a technological device or procedure related to human perception of light (e.g., eyeglasses, contact lenses, infrared or low light vision sensors, laser surgery), and evaluate its effectiveness [AI, C]

Sample issue: Laser surgery corrects vision by surgically reshaping the cornea to correct refractive defects in the eye. While the procedure is effective in most cases, it poses risks and can in some cases lead to poor night vision.

Sample questions: How do anti-glare night vision glasses help people who have difficulty driving at night? How do eyeglasses with colour filters help people with dyslexia to read?

**Catholic Graduate Expectation(s):**

- CGE2b: Reads, understands and uses written materials effectively.
- CGE2e: Uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.
- CGE4e: Sets appropriate goals and priorities in school, work and personal life.
- CGE4f: Applies effective communication, decision-making, problem-solving, time and resource management skills.
- CGE5a: Works effectively as an interdependent team member.
- CGE5b: Thinks critically about the meaning and purpose of work.
- CGE5g: Achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others.

**Learning Goal(s):**

- Evaluate the effectiveness of an optical device or procedure on people and our society.
- Communicate clearly in chosen format and use terminology appropriately.

**Big Idea(s):**

- **Society has benefited from the development of a range of optical devices and technologies**

**Assessment and Evaluation**

**Assessment/Success Criteria**

*Communication*

- Expresses and organizes ideas and information clearly in chosen format.
- Uses scientific terminology appropriately.

*Application*

- Transfers knowledge of light, mirrors and/or lenses to unfamiliar contexts
- Makes connections by evaluating the effectiveness of a technological device/procedure on people and our society

**Assessment Tools ...**

- observations
- oral feedback
- anecdotal comments
- rubric
- reflection

**Prior Learning**

Prior to this lesson, students will have:

- some familiarity with the concept of light and the human eye through personal experiences

**Materials and Resources**

**Materials:**

Appendix 1.1: Blind Spot Testers (internet source unknown)  
 Appendix 1.2: Word Sort  
 Appendix 1.3: Brainstorming  
 Appendix 1.4: RAFT  
 Appendix 1.5: Rubric  
 Appendix 1.6: Clock partners  
 Appendix 1.7: Product Choice Reflection and Progress Due Dates  
 Appendix 1.8: Background information on the human eye and some defects.

**Resources:**

Adam-Carr, Christine, et al. (2010) Science Perspectives 10. Toronto: Nelson Education Ltd.

Dickinson, Tom et al. (2009) ON Science 10. Toronto, ON: McGraw-Hill Ryerson Limited.

Science 9. Toronto, ON: Nelson Canada, 1995.

Hume, Karen. (2008). Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM). Toronto, ON: Pearson Education Canada.

Institute for Catholic Education. (2003). Ontario Catholic School Graduate Expectations.

Ministry of Education 2008. The Ontario Curriculum, Grades 9 and 10, Science.

Ritter, Bob et al. (1995) Science 9. Scarborough, ON: Nelson Canada.



## Grade 10 Science, Academic/SNC2D/The Human Eye/Lesson # 1

### Minds On (25 min)

- ♦ Establishing a positive learning environment
- ♦ Connecting to prior learning and/or experiences
- ♦ Setting the context for learning

### Connections

L: Literacy  
ML: Mathematical Literacy  
AfL: Assessment **for** Learning  
DI: Differentiated Instruction

### Pairs ⇒ Think-Pair-Share: Blind Spot Testers

Each pair of students is given a Blind Spot Tester (Appendix 1.1). Individually, students think about how they can use the Blind Spot Tester to find their blind spot. In pairs, they share and test their ideas.

Circulate and provide feedback as appropriate.

Teacher explains how to find an eye's blind spot using Appendix 1.1.

Hold one happy/sad face blind spot tester at an arm's length away. The sad face should be in line with the left eye and the happy face should be in line with the right eye.

Cover your left eye; your right eye should focus on the sad face.

Slowly bring the blind spot tester closer to your face. There will be a particular point where the happy face will "disappear". This means light reflected from the happy face is reaching your blind spot where the optical attaches to the retina and there are no light receptors.

Repeat by covering your right eye and focusing your left eye on the happy face. Bring the blind spot tester closer and the sad face will disappear.

AfL: Observations/Oral Feedback

### Groups of 4 ⇒ Word Sort

Using Appendix 1.2, students cut out the words and arrange them into categories that make sense to them, leaving out the words that they don't know the meaning to.

Using Appendix 1.3, students brainstorm what they know and what they wonder about the different words.

To generate more discussion, consider using a cooperative learning strategy such as "*jigsaw*" or "*two stay one strays*". Consider using this activity to pre-assess students' prior knowledge with optics.

AfL: Observations/Anecdotal Comments/Pre-assessment

### Action (25 min)

- ♦ Introducing new learning or extending/reinforcing prior learning
- ♦ Providing opportunities for practice and application of learning (guided → independent)

### Whole Class Discussion ⇒ The Human Eye

Facilitate a discussion on how the human eye functions.

### Individuals, Pairs or Small Groups ⇒ Brainstorming

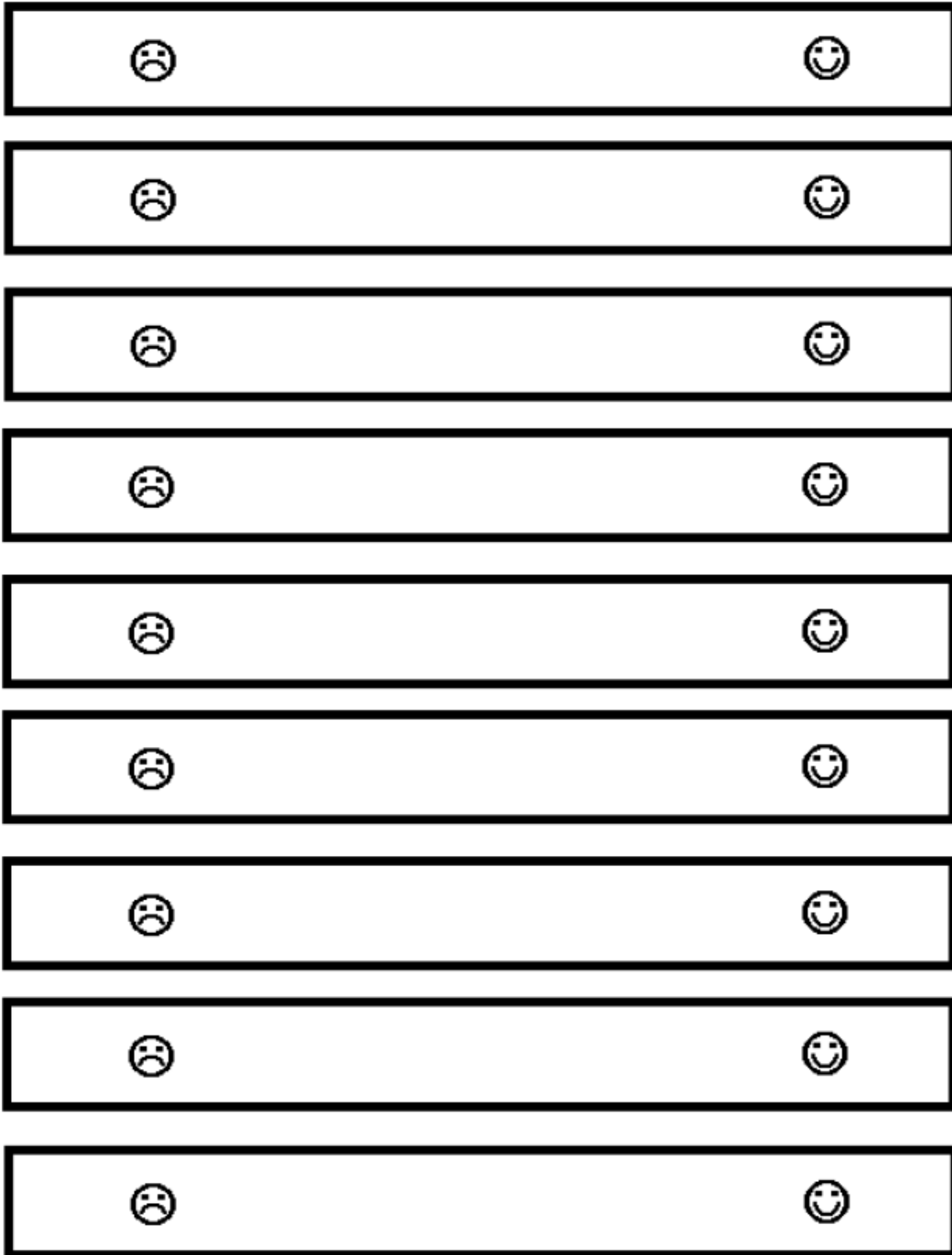
Individually (intrapersonal), in pairs or small groups (interpersonal), students brainstorm what they think is important to study in science in order to understand the functions of the eye.

Consider

- cueing students with probing questions to generate ideas such as

DI: Learning Preferences

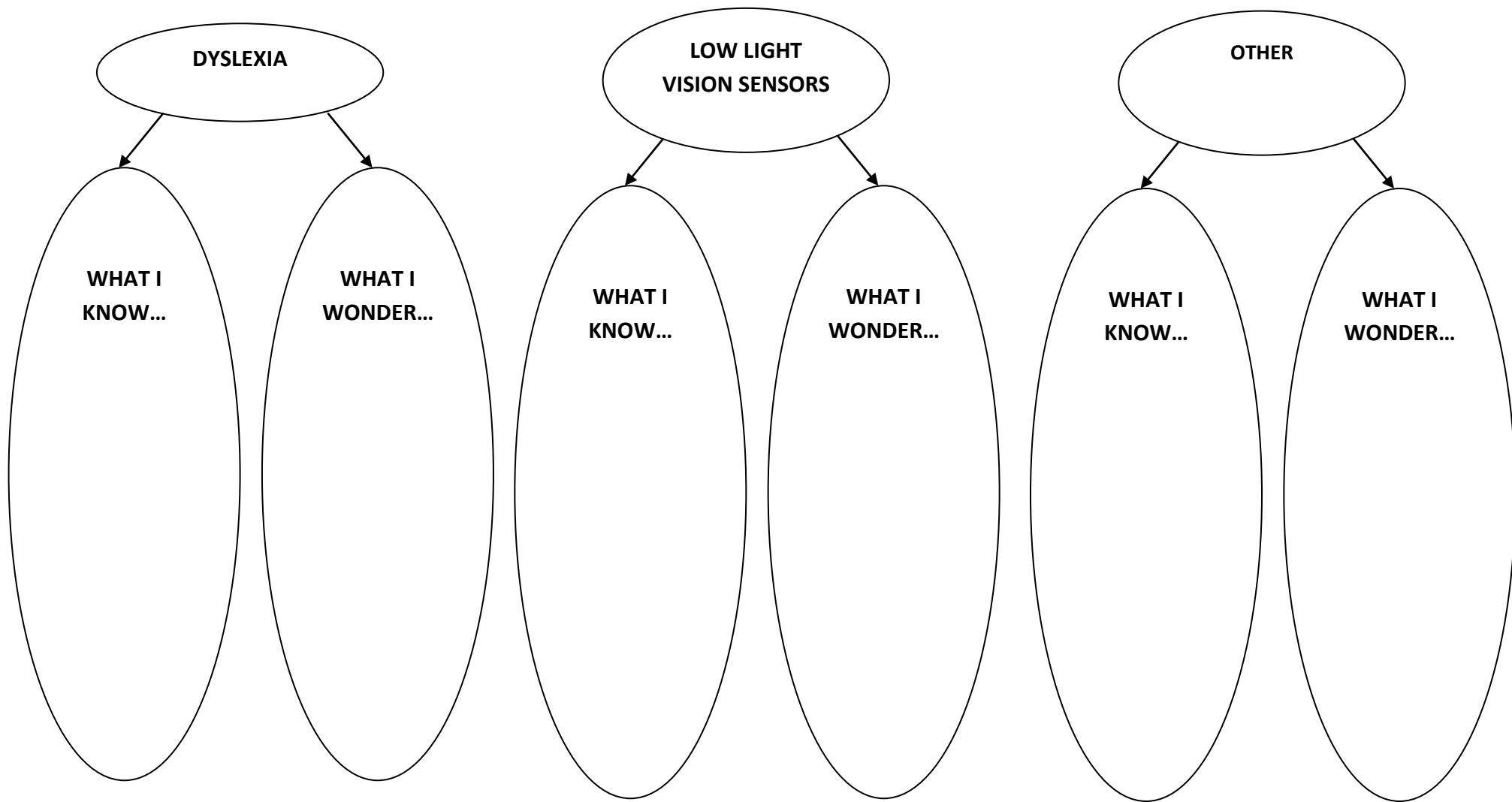
<p><i>lenses, images, magnification, etc</i></p> <ul style="list-style-type: none"> <li>• co-constructing some of the learning goals for the unit based on the brainstorming ideas</li> <li>• using this activity to pre-assess students' prior knowledge of optics</li> </ul> <p><b>Individuals ⇒ RAFT: Technological Devices and Procedures</b>          Introduce and explain the RAFT assignment (Appendix 1.4) and share the success criteria using a Rubric (Appendix 1.5).          Students review the different possibilities and decide what they want to work on. Consider a deadline towards the end of the unit to allow students to incorporate the knowledge they acquire throughout the unit. This assignment can be evaluated. Consider providing opportunities to assess the progress of the assignment throughout the unit.</p>	<p>AfL: Co-constructing Learning Goals          AfL: Observations/Anecdotal Comments/Pre-assessment</p> <p>DI: RAFT          AfL/AoL: Rubric/RAFT Assignment</p>
<p><b>Consolidation and Connection (25 min)</b></p> <ul style="list-style-type: none"> <li>♦ Helping students demonstrate what they have learned</li> <li>♦ Providing opportunities for consolidation and reflection</li> </ul>	
<p><b>Individual ⇒ Product Choice Reflection</b>          Students reflect on why they chose the format for their technological device/procedure project and come up with two or three research questions that they will need to answer to understand the technology or procedure before they can answer their topic question (see Appendix 1.7).</p>	<p>AaL: Product Choice Reflection</p>

**Blind Spot Testers**

**Word Sort**

<b>eyeglasses</b>	<b>contact lenses</b>	<b>infrared or low light vision sensors</b>
<b>laser surgery</b>	<b>shortsightedness (myopia)</b>	<b>lens</b>
<b>human eye</b>	<b>farsightedness (hyperopia)</b>	<b>anti-glare</b>
<b>cornea</b>	<b>astigmatism</b>	<b>dyslexia</b>
<b>pupil</b>	<b>retina</b>	

**Brainstorming****LASER SURGERY****WHAT I  
KNOW...****WHAT I  
WONDER...****GLASSES/  
CONTACT LENSES****WHAT I  
KNOW...****WHAT I  
WONDER...****ANTI-GLARE****WHAT I  
KNOW...****WHAT I  
WONDER...**



## RAFT for Technological Device/Procedure

### Learning Goals

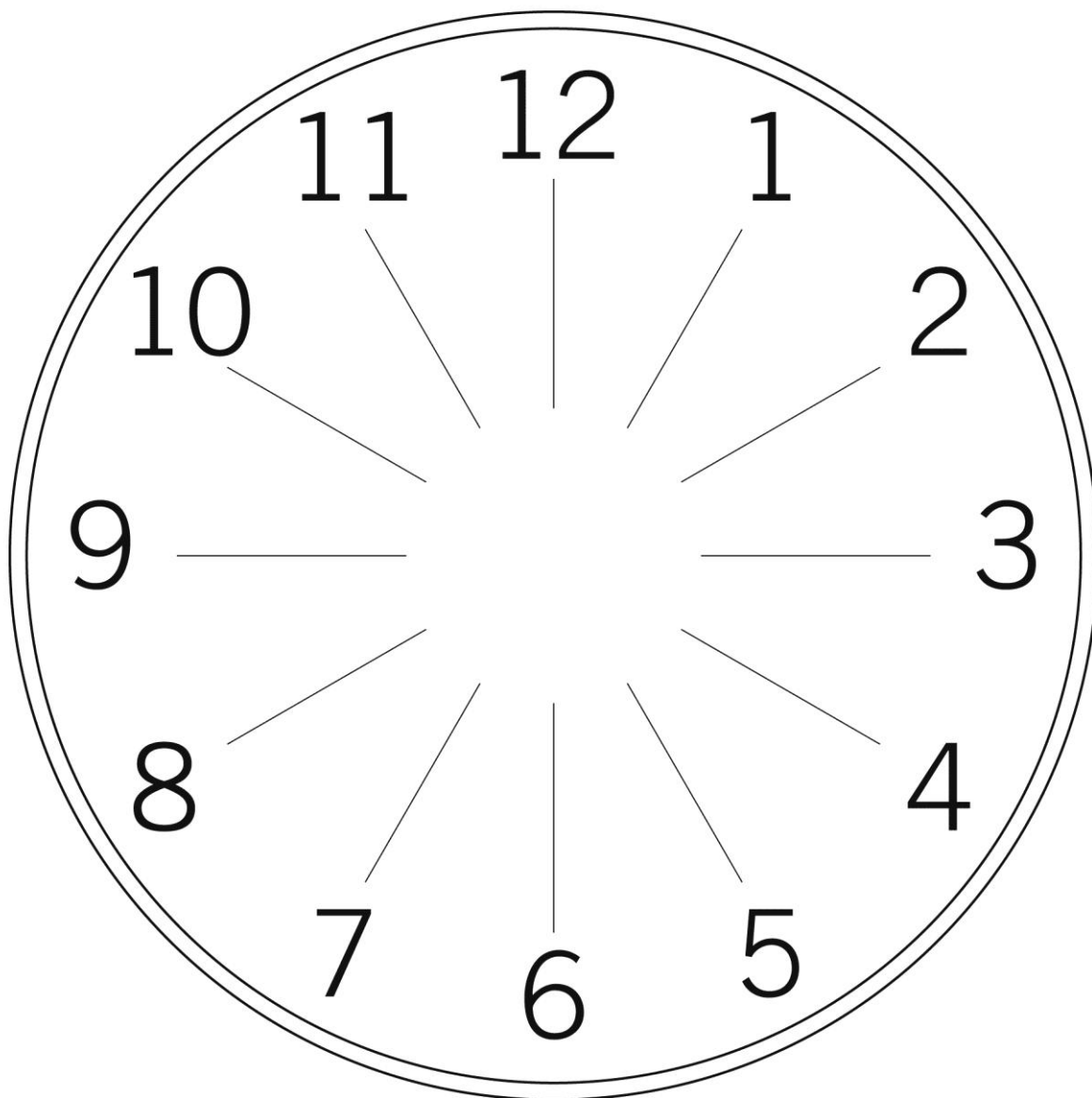
- Analyse a technological device or procedure related to human perception of light (e.g., eyeglasses, contact lenses, infrared or low light vision sensors, laser surgery), and evaluate its effectiveness.
- Understand how the human eye functions and how the chosen technological device or procedure benefits the user.

Role	Audience	Format	Topic
TV reporter	general public	video or role play (5 minutes max)	How effective is laser eye surgery?
company president/CEO	district managers at a company meeting	short PowerPoint presentation (10 slides max) including charts by the CEO to the district managers	How do low light vision sensors function?
newspaper reporter	grade 5-6 students	Short newspaper feature based on an interview. Feature may include graphics, charts.	How do eyeglasses with colour filters help people with dyslexia to read?
artist	high school students	song, cartoon	How do anti-glare night vision glasses help people who have difficulty driving at night?

## Final Product Assessment Rubric

Criteria	Level R	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)	Sub- Total
	Marks 0	Marks 2	Marks 2.5	Marks 3	Marks 4	
<b>Application</b>						
Brief introduction explains the topic to be discussed.	No introduction to the topic.	demonstrates limited knowledge of content	demonstrates some knowledge of content	demonstrates considerable knowledge of content	demonstrates thorough knowledge of content	
Topic question is answered.	Topic sentence in unanswered.	transfers knowledge and skills to unfamiliar contexts with limited effectiveness	transfers knowledge and skills to unfamiliar contexts with some effectiveness	transfers knowledge and skills to unfamiliar contexts with considerable effectiveness	transfers knowledge and skills to unfamiliar contexts with a high degree of effectiveness	
Makes Connections between science, technology and society.	Cannot answer questions.	makes connections between science, technology and society with limited effectiveness	makes connections between science, technology and society with some effectiveness	makes connections between science, technology and society with considerable effectiveness	makes connections between science, technology and society with a high degree of effectiveness	
<b>TOTAL</b>						<b>/12</b>
<b>Communication</b>						
Expression and Organization of information (clear expression, logical organization, charts and diagrams where needed) in chosen format	no organization	expresses and organizes ideas and information with limited effectiveness	expresses and organizes ideas and information with some effectiveness	expresses and organizes ideas and information with considerable effectiveness	expresses and organizes ideas and information with a high degree of effectiveness	
use of vocabulary, and terminology of the discipline	does not use correct vocabulary or terminology	uses vocabulary and terminology with limited effectiveness	uses vocabulary and terminology with some effectiveness	uses vocabulary and terminology with considerable effectiveness	uses vocabulary and terminology with a high degree of effectiveness	
Communication for difference audiences and purposes	does not communicate with the audience and purpose in mind	communicates for different audiences and purposes with limited effectiveness	communicates for different audiences and purposes with some effectiveness	communicates for different audiences and purposes with considerable effectiveness	communicates for different audiences and purposes with a high degree of effectiveness	
<b>TOTAL</b>						<b>/12</b>



**Learning Partners Clock**

source: Hume, Karen. (2008). Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM). Toronto, ON: Pearson Education Canada  
(Learning Partners Clock —Black Line Master 5.4)

**Product Choice Reflection and Progress Due Dates**

My choice of format: \_\_\_\_\_

The learning outcomes my product will demonstrate:

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I think this choice is a good way for me to demonstrate these outcomes because

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I know that this choice is a strength for me because

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Or

This product is something I would like to get good at because

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The resources I think I will need for this work are (think about equipment, time, knowledge, and whom you can go to for expert assistance if needed)

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Before you can answer the topic question, you may need to do some background research on your chosen technological device/product. List some research questions below:

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source: Hume, Karen. (2008). Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM). Toronto, ON: Pearson Education Canada (Product Choice Reflection — Black Line Master 11.4)

## Progress Due Dates

Background info on topic is due on \_\_\_\_\_.

Outline of final product is due on \_\_\_\_\_.

Rough draft or script of final product is due on \_\_\_\_\_.

Final product is due on \_\_\_\_\_.

## Grade 10 Science, Academic (SNC2D): Light and Geometric Optics

### Lesson 4/Plane Mirror Reflection

**Duration:** 75 minutes (1 period)

Key Instructional Strategies		Differentiated Instruction Details
1	"Two Stay One Strays": Word Matching (Cooperative Learning)*	<b>Knowledge of Students</b> Differentiation based on student: ✓ Readiness <input type="checkbox"/> Interests    ✓ Preferences  <b>Differentiated Instruction Response</b> <input type="checkbox"/> Learning materials (content) ✓ Ways of learning (process) <input type="checkbox"/> Ways of demonstrating learning (product) <input type="checkbox"/> Learning environment
2	Learning Centres or Stations**	
3	Whole Class Discussion: The Laws of Reflection (Questions and Cues)*	

\*Marzano's Categories of Instructional Strategies    \*\*Differentiated Instruction Structure

### Curriculum Connections

#### Overall Expectation(s):

A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating);

E3. demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses.

#### Specific Expectation(s):

A1.5 conduct inquiries, controlling some variables, adapting or extending procedures as required, and using standard equipment and materials safely, accurately, and effectively, to collect observations and data

A1.6 gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

A1.12 use appropriate numeric, symbolic, and graphic modes of representation, and appropriate units of measurement (e.g., SI and imperial units)

E2.1 use appropriate terminology related to light and optics, including, but not limited to: angle of incidence, angle of reflection, etc...

E2.2 use an inquiry process to investigate the laws of reflection, using plane and curved mirrors, and draw ray diagrams to summarize their findings

#### Catholic Graduate Expectation(s):

CGE2a: Listens actively and critically to understand and learn in light of gospel values.

CGE3c: Thinks reflectively and creatively to evaluate situations and solve problems.

CGE5a: Works effectively as an interdependent team member.

CGE5b: Thinks critically about the meaning and purpose of work.

CGE4a: Demonstrates a confident and positive sense of self and respect for the dignity and welfare of others.

<b>Learning Goal(s):</b> <ul style="list-style-type: none"> <li>• Use appropriate terminology related to reflection.</li> <li>• Conduct an inquiry to discover the relationship between the angle of incidence and the angle of reflection.</li> </ul>	<b>Big Idea(s):</b> <b>Light has characteristics and properties that can be manipulated with mirrors and lenses for a range of uses.</b>
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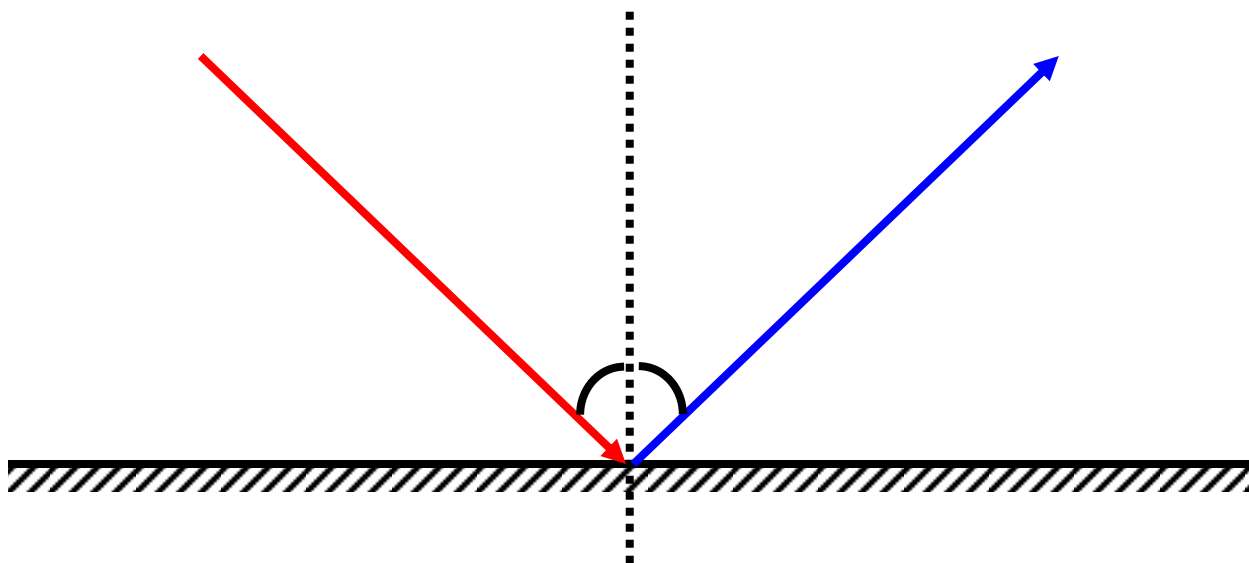
Assessment and Evaluation	
<b>Assessment/Success Criteria</b> <i>Knowledge and Understanding</i> <ul style="list-style-type: none"> <li>• knowledge of terminology</li> <li>• understanding of the laws of reflection</li> </ul> <i>Thinking and Investigation</i> <ul style="list-style-type: none"> <li>• use of initiating and planning skills and strategies to discover that the angle of incidence is equal to the angle of reflection (station 1)</li> <li>• use of processing skills and strategies to discover that the angle of incidence is equal to the angle of reflection (station 3 and 4)</li> <li>• use of critical/creative thinking processes, skills, and strategies to hit targets around a room using the laws of reflection (station 2)</li> </ul>	<b>Assessment Tools</b> (i.e., checklist, rubric, anecdotal comments): <ul style="list-style-type: none"> <li>• observations</li> <li>• oral feedback</li> </ul>

Prior Learning
Prior to this lesson, students will have: <ul style="list-style-type: none"> <li>• an understanding that light travels in straight lines.</li> <li>• learned about the different sources of light, the electromagnetic spectrum. the properties of light, and how light is created.</li> </ul>

Materials and Resources
<b>Materials:</b> Appendix 4.1: Word Matching Appendix 4.2: Definitions Appendix 4.3: Reflecting Light off a Plane Mirror Appendix 4.4: Reflection Obstacle Course <b>Internet Resources:</b> Henderson, Tom. <u>The Physics Classroom: The Law of Reflection</u> . 9 August 2010. <a href="http://www.physicsclassroom.com/Class/refln/u13l1c.cfm">http://www.physicsclassroom.com/Class/refln/u13l1c.cfm</a> Oracle ThinkQuest: <u>Laws of Reflection</u> . August 1999. 9 August 2010. <a href="http://library.thinkquest.org/27948/reflect.html">http://library.thinkquest.org/27948/reflect.html</a> <b>Resources:</b> Hume, Karen. (2008). <u>Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM)</u> . Toronto, ON: Pearson Education Canada Institute for Catholic Education. (2003). <i>Ontario Catholic School Graduate Expectations</i> . Ministry of Education 2008. <i>The Ontario Curriculum, Grades 9 and 10, Science</i> . ON Science 10. Toronto, ON: McGraw-Hill Ryerson Limited, 2009. Science 9. Toronto, ON: Nelson Canada, 1995. Science Perspectives 10. Toronto, ON: Nelson Education Ltd, 2010.

<b>Grade 10 Science, Academic/SNC2D/Activity Title/Lesson #4</b>	
<b>Minds On (20 min)</b> <ul style="list-style-type: none"> <li>♦ Establishing a positive learning environment</li> <li>♦ Connecting to prior learning and/or experiences</li> <li>♦ Setting the context for learning</li> </ul>	<b>Connections</b> L: Literacy ML: Mathematical Literacy AfL: Assessment <b>for</b> Learning DI: Differentiated Instruction
<b>Whole Class or Groups of 3 ⇒ Diagram Word Matching</b>  Provide each group with a diagram and a set of words. The students must cut out the words and place them on the diagram correctly (Appendix 4.1). Consider using a cooperative learning strategy such as “jigsaw” or “two stay one strays” to generate more discussion and ensure that diagrams have a greater success rate at being correctly labeled. Once all groups are satisfied that their diagrams are labeled correctly, the teacher will reveal the answer key. The groups are then asked to formulate their own definitions of each word. Reveal the textbook definitions at the end of the period (Appendix 4.2).  Share and discuss the learning goals.	AfL: Sharing and discussing learning goals
<b>Action (30 min)</b> <ul style="list-style-type: none"> <li>♦ Introducing new learning or extending/reinforcing prior learning</li> <li>♦ Providing opportunities for practice and application of learning (guided → independent)</li> </ul>	
<b>Groups of 3 or individual ⇒ Laws of Reflection Learning Stations</b>  Four types of learning stations will be available for students to learn the Laws of Reflection. The teacher may decide to assign the students to a station or let the students choose their preferred station.  Station 1 – Hands-On Activity (Appendix 4.3) Science Perspectives 10. Toronto, ON: Nelson Education Ltd, 2010. pg 482-483  Station 2 – Enhanced Hands-On Activity: Reflection Obstacle Course (Appendix 4.4) ON Science 10. Toronto, ON: McGraw-Hill Ryerson Limited, 2009. pg 413  Station 3 – Reading and Answering Questions Have students read the section associated with the Laws of Reflection and answer the questions pertaining to that section. Nelson 10 Perspectives pg 481 – 486 ON Science 10 pg411-414 You may extend this to have them explore an internet site such as the Physics Classroom which has animations and questions after every topic. <a href="http://www.physicsclassroom.com/Class/refln/u13l1c.cfm">http://www.physicsclassroom.com/Class/refln/u13l1c.cfm</a>  Station 4 – Java Applet with Questions	DI: Learning Stations/ Preferences

<p>Have students explore a Java applet and answer the questions in Appendix 4.3.  <a href="http://library.thinkquest.org/27948/reflect.html">http://library.thinkquest.org/27948/reflect.html</a></p> <p>Circulate and provide feedback when necessary.</p>	<p>AfL: Observations/Oral Feedback</p>
<p><b>Consolidation and Connection (20 min)</b></p> <ul style="list-style-type: none"> <li>♦ Helping students demonstrate what they have learned</li> <li>♦ Providing opportunities for consolidation and reflection</li> </ul>	
<p><b>Whole Class ⇒ Laws of Reflection Discussion</b></p> <p>Facilitate a discussion on the laws of reflection. Choose a representative from each station to share with the class what they did at their station, what their results were and their conclusions.</p> <p>Write the laws on the board for the students to copy and provide them with an answer key to the definition of the terms explored at the beginning of the class. (Appendix 4.2)</p> <p>Assign homework from the textbook if necessary.</p>	<p>AfL: Observations/Oral Feedback</p> <p>AfL: Homework</p>

**Word Matching**

angle of incidence	incident ray	mirror
angle of reflection	reflected ray	normal
$\theta_i$	point of incidence	$\theta_r$



## Definitions

**point of incidence**

The spot where the incident ray strikes the surface.

**incident ray**

The ray of light that travels towards a reflecting surface

**angle of incidence ( $\theta_i$ )**

The angle between the incident ray and the normal.

**angle of reflection ( $\theta_r$ )**

The angle between the reflected ray and the normal.

**reflected ray**

The ray of light that bounces off a reflecting surface.

**normal**

An imaginary line drawn perpendicular to the reflecting surface at the point of incidence.

**plane mirror**

Flat polished surface that reflects light.

## Reflecting Light Off a Plane Mirror

### PURPOSE

To compare the angle of incidence with the angle of reflection in a plane mirror.

### MATERIALS

- 1 ray box
- 1 plane mirror with mirror supports
- 1 sheet of polar coordinate paper
- 1 slit mask

### PROCEDURE

1. Place a mirror on the horizontal line of the polar coordinate paper. Because the back or silvered part of the mirror is the reflective part, the back of the mirror should be on the line, not the glass part of the mirror.
2. Place a slit mask on the ray box so that only one ray of light comes out. Aim the incident ray along the normal ( $\theta_i = 0^\circ$ ). Measure the angle of reflection using the polar coordinate paper. Record your observation in Table 1. Remember to measure all your angles from the normal.
3. Align the incident ray for the following angles of incidence:  $10^\circ$ ,  $20^\circ$ ,  $40^\circ$ ,  $60^\circ$ . Measure the angles of reflection and record them in Table 1. Make sure to direct the ray at the point where the normal intersects with the mirror.

Table 1 – \_\_\_\_\_

Trial	Angle of Incidence ( $\theta_i$ )	Angle of Reflection ( $\theta_r$ )
1	0.0	
2	10.0	
3	20.0	
4	40.0	
5	60.0	

### ANALYZE AND EVALUATE

- a. How did the angle of incidence compare with the angle of reflection?
- b. In trial 1, you aimed the incident ray directly along the normal. Describe the path of the incident and reflected rays for this special case.
- c. Where might errors occur in this activity? Think of at least two.
- d. How would these errors affect your conclusion?
- e. How can you improve this experiment to reduce or eliminate the two errors you described in (c). Provide one improvement for each error.

### APPLY AND EXTEND

- f. Billiards is a game that makes use of reflection. How would the results of this activity help you in such a game?
- g. What other sports or activities make use of the reflection rule you discovered in this activity? Explain.



source: Science Perspectives 10. Toronto, ON: Nelson Education Ltd, 2010.

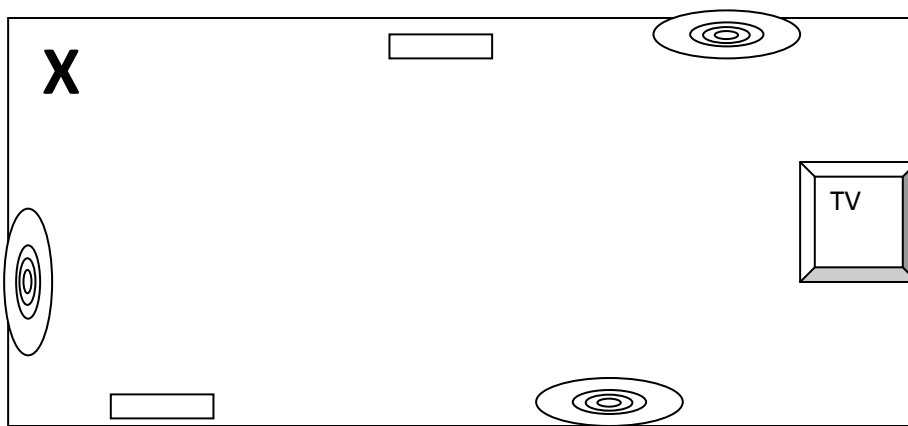
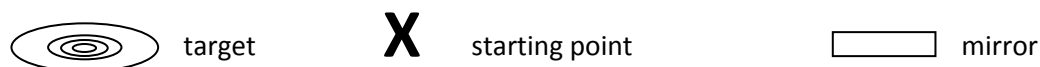
**Reflection Obstacle Course****Teacher instructions:**

Set up 3 different targets in the room at different heights.

Set up a television with a remote control.

Set up 2 plane mirrors around the room.

Decide on the starting point for the students. See sample classroom set up below:



From the starting point, students must aim the laser at the mirrors and hit the targets. They can try to use the mirrors in as many different ways as possible to hit one target.

From the starting point, students must aim the remote control at the mirrors and turn on the TV.

Since using a laser while the rest of the class is working at different stations may be a safety risk, simply have the students move the television to the different target locations and use the remote control only. You can also use a flashlight and simply move the targets closer to the starting point.

This activity can be extended by

- using more targets and more mirrors,
- having students hit more than one target at once,
- having students choose the locations of the targets and mirrors.

## **PURPOSE**

To discover the Laws of Reflection and apply them to hit targets with a source of light and mirrors.

## **MATERIALS**

- 3 targets
- 2 plane mirrors
- 1 flashlight or laser
- 1 remote control
- 1 television

## **SAFETY PRECAUTION**

Never direct a light source at someone's eyes.

## **PROCEDURE**

1. Your teacher will set up different targets at different heights in the classroom. A television will also be set up.
2. Two plane mirrors will be set up in the classroom also.
3. Stand at the designated starting point and using the flashlight or laser, direct the light so that it reflects off one mirror or both mirrors and hits one of the targets. Repeat for the other two targets. You can change the angle at which the mirrors are positioned if necessary.
4. Use the remote control as a source of invisible electromagnetic radiation, try to turn the television by reflecting this invisible source. You can change the angle at which the mirrors are positioned if necessary.

## **ANALYZE AND EVALUATE**

- a. Did you have to change the position of the mirrors to hit the targets? If yes, How did you position them?
- b. How did the angle of incidence compare with the angle of reflection?
- c. Where might errors occur in this activity? Think of at least two.
- d. How would these errors affect your conclusion?
- e. How can you improve this experiment to reduce or eliminate the two errors you described in (c). Provide one improvement for each error.

## **APPLY AND EXTEND**

- f. Billiards is a game that makes use of reflection. How would the results of this activity help you in such a game?
- g. What other sports or activities make use of the reflection rule you discovered in this activity? Explain.



sources:

Science Perspectives 10. Toronto, ON: Nelson Education Ltd, 2010. pg 482-483

ON Science 10. Toronto, ON: McGraw-Hill Ryerson Limited, 2009. pg 413

## Grade 10 Science, Academic (SNC2D): Light and Geometric Optics

### Lesson 5/Locating Images in a Plane Mirror

**Duration:** one 75 minute period

Key Instructional Strategies		Differentiated Instruction Details
1	Performing a lab/ Guided Inquiry	<b>Knowledge of Students</b> Differentiation based on student: <input type="checkbox"/> Readiness <input type="checkbox"/> Interests <input type="checkbox"/> Preferences <b>Differentiated Instruction Response</b> <input type="checkbox"/> Learning materials (content) <input type="checkbox"/> Ways of learning (process) <input type="checkbox"/> Ways of demonstrating learning (product) <input type="checkbox"/> Learning environment

\*Marzano's Categories of Instructional Strategies \*\*Differentiated Instruction Structure

### Curriculum Connections

#### Overall Expectation(s):

- A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating);
- E2. investigate, through inquiry, the properties of light, and predict its behaviour, particularly with respect to reflection in plane and curved mirrors and refraction in converging lenses;
- E3. demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses.

#### Specific Expectation(s):

- A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible
- A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions
- E2.1 use appropriate terminology related to light and optics, including, but not limited to: angle of incidence, angle of reflection, angle of refraction, focal point, luminescence, magnification, mirage, and virtual image [C]
- E2.2 use an inquiry process to investigate the laws of reflection, using plane and curved mirrors, and draw ray diagrams to summarize their findings [PR, C]
- E2.3 predict the qualitative characteristics of images formed by plane and curved mirrors (e.g., location, relative distance, orientation, and size in plane mirrors; location, orientation, size, type in curved mirrors), test their predictions through inquiry, and summarize their findings [PR, AI, C]
- E3.3 describe, on the basis of observation, the characteristics and positions of images formed by plane and curved mirrors (e.g., location, orientation, size, type), with the aid of ray diagrams and algebraic equations, where appropriate

#### Catholic Graduate Expectation(s):

- CGE2a: Listens actively and critically to understand and learn in light of gospel values.
- CGE4a: Demonstrates a confident and positive sense of self and respect for the dignity and welfare of others.
- CGE5a: Works effectively as an interdependent team member.
- CGE5b: Thinks critically about the meaning and purpose of work.
- CGE5g: Achieves excellence, originality, and integrity in one's own work and supports these qualities

in the work of others.	
<b>Learning Goal(s):</b> <ul style="list-style-type: none"> <li>• Demonstrate an understanding of the law of reflection.</li> <li>• Demonstrate an understanding of the difference between a real image and a virtual image.</li> <li>• Draw ray diagrams to locate an image in a plane mirror.</li> </ul>	<b>Big Idea(s):</b> <ul style="list-style-type: none"> <li>• Light has characteristics and properties that can be manipulated with mirrors and lenses for a range of uses.</li> </ul>

### Assessment and Evaluation

<b>Assessment/Success Criteria</b> <i>Knowledge and Understanding</i> <ul style="list-style-type: none"> <li>• knowledge of terminology</li> <li>• understanding of the law of reflection</li> </ul> <i>Thinking and Investigation</i> <ul style="list-style-type: none"> <li>• use of processing skills and strategies to discover how an image can be located in a plane mirror by following a step-by-step procedure</li> <li>• use of critical/creative thinking processes, skills, and strategies to answer questions based on evidence gathered during the activity</li> </ul>	<b>Assessment Tools</b> <ul style="list-style-type: none"> <li>• observations</li> <li>• anecdotal comments</li> <li>• marking scale</li> </ul>
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### Prior Learning

Prior to this lesson, students will have: <ul style="list-style-type: none"> <li>• learned that the angle of incidence is equal to the angle of reflection</li> <li>• learned that light travels in straight lines</li> <li>• used a ray box</li> </ul>
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### Materials and Resources

<b>Materials:</b> <ul style="list-style-type: none"> <li>• 1 ray box</li> <li>• 1 plane mirror with mirror supports</li> <li>• 1 pen or pencil</li> <li>• 1 slit mask</li> <li>• 1 ruler</li> </ul> Appendix 5.1: Locating Images in Plane Mirrors  <b>Internet Resources:</b> <p>Real and Virtual Image Illusions. July 15, 1998. LECTURE DEMONSTRATION MANUAL- Instructional Research Lab : ucla physics. 20 August 2010.  <a href="http://www.physics.ucla.edu/demoweb/demomanual/optics/geometrical_optics/real_and_virtual_image_illusions.html">http://www.physics.ucla.edu/demoweb/demomanual/optics/geometrical_optics/real_and_virtual_image_illusions.html</a></p> <p>Real Images and Holograms. Mirage by Opti-Gone International. 20 August 2010.  <a href="http://www.optigone.com/3D_hologram.htm">http://www.optigone.com/3D_hologram.htm</a></p>
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**Resources:**

- Adam-Carr, Christine, et al. (2010) Science Perspectives 10. Toronto: Nelson Education Ltd.
- Dickinson, Tom et al. (2009) ON Science 10. Toronto, ON: McGraw-Hill Ryerson Limited.
- Science 9. Toronto, ON: Nelson Canada, 1995.
- Hume, Karen. (2008). Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM). Toronto, ON: Pearson Education Canada.
- Institute for Catholic Education. (2003). Ontario Catholic School Graduate Expectations.
- Ministry of Education 2008. The Ontario Curriculum, Grades 9 and 10, Science.
- Ritter, Bob et al. (1995) Science 9. Scarborough, ON: Nelson Canada.

**Grade 10 Science, Academic/SNC2D/ Locating Images in a Plane Mirror /Lesson # 5**

## Minds On (10 min)

- ◆ Establishing a positive learning environment
- ◆ Connecting to prior learning and/or experiences
- ◆ Setting the context for learning

## Connections

L: Literacy  
ML: Mathematical Literacy  
AfL: Assessment **for** Learning  
AaL: Assessment **as** Learning  
AoL: Assessment **of** Learning  
DI: Differentiated Instruction  
EE: Environmental Education

**Whole Class  $\Rightarrow$  Class Discussion**

Using questions and cues review with the class what they learned in the previous lesson (angle of incidence = angle of reflection)

**Whole Class  $\Rightarrow$  Teacher Demo and Discussion**

Intrigue your students with two demos, one creates a real image, the other a virtual image. See links below for description of the two demos.  
The real image demonstration will require a Mirage® 3D Hologram Maker.

[http://www.physics.ucla.edu/demoweb/demomanual/optics/geometrical\\_optics/real\\_and\\_virtual\\_image\\_illusions.html](http://www.physics.ucla.edu/demoweb/demomanual/optics/geometrical_optics/real_and_virtual_image_illusions.html)

[http://www.optigone.com/3D\\_hologram.htm](http://www.optigone.com/3D_hologram.htm)

Share and discuss the learning goals.

AfL: Sharing and discussing learning goals

### Action (40 min)

- ◆ Introducing new learning or extending/reinforcing prior learning
- ◆ Providing opportunities for practice and application of learning (guided → independent)

### Small Groups $\Rightarrow$ Locating Images in Mirrors Activity

Provide students with activity handout (Appendix 5.1). The handout is designed for students to read and follow the instructions step by step. Depending on your class, you may wish to briefly demo the activity before they begin.

Consider assessing the activity using the scale provided.

### AfL: Marking Scale

### Consolidation and Connection (20 min)

- ◆ Helping students demonstrate what they have learned
- ◆ Providing opportunities for consolidation and reflection

### Small Groups $\Rightarrow$ Definitions

You have briefly introduced the terms real image and virtual image. Have the students come up with definitions for these two terms.

## Whole Class $\Rightarrow$ Definitions

Have each group write their definitions on the board and as a class choose the two definitions that best describe a real image and a virtual image.  
Introduce them to the acronym SALT to describe an image.



**Small Groups ⇒ Extension Activity**

Consider asking the students to explain how the Mirage® 3D Hologram Maker works and why is the image it creates considered a real image.

For the answer, refer to [http://www.optigone.com/3D\\_hologram.htm](http://www.optigone.com/3D_hologram.htm) .

To generate more discussion, consider using a cooperative learning strategy such as “*jigsaw*” or “*two stay one strays*”. Circulate and make observations to help guide further instruction.

AfL: Observations

**Locating Images in a Plane Mirror**

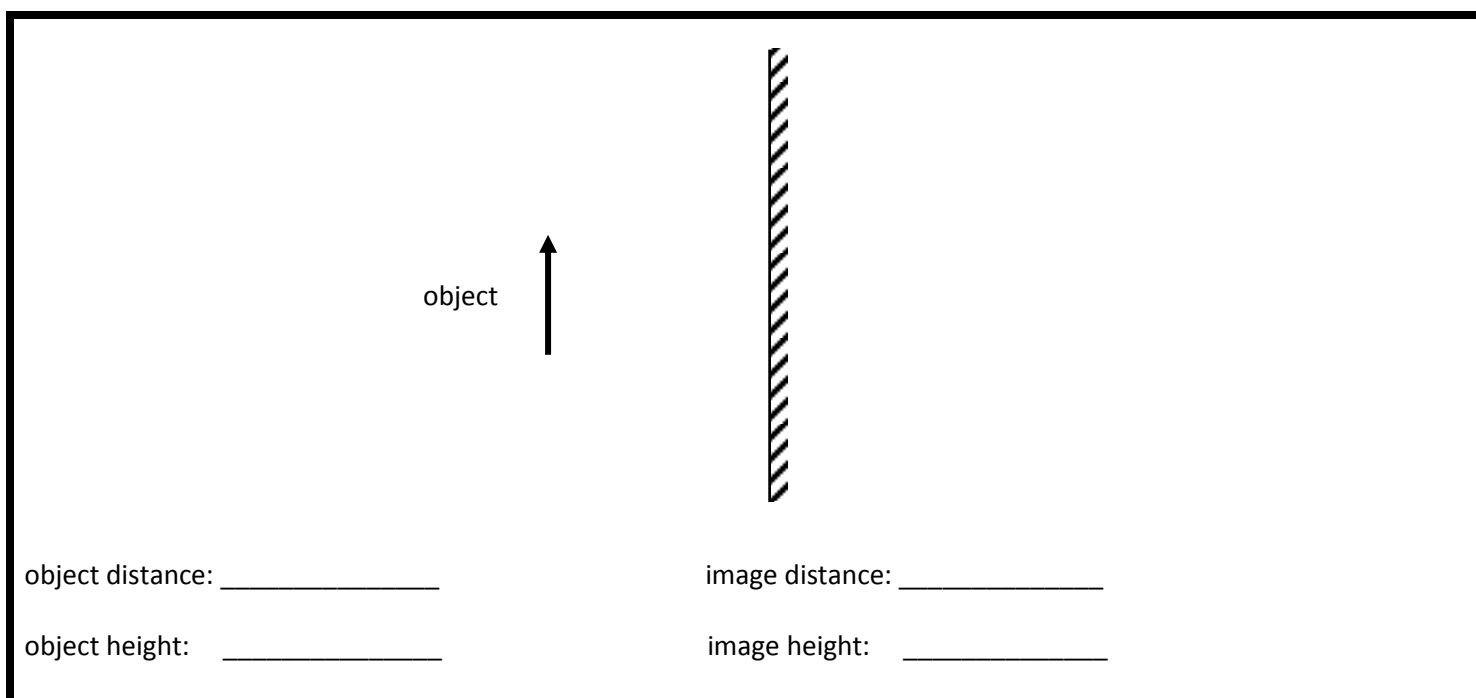
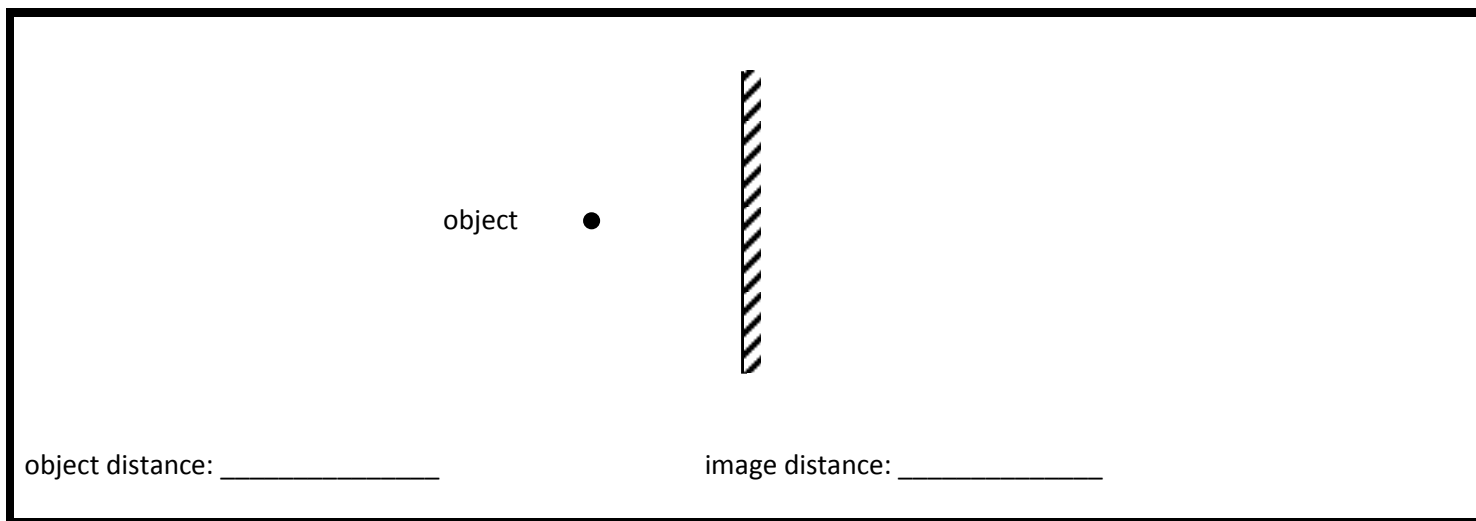
adapted from: Ritter, Bob et al. (1995) Science 9. Scarborough, ON: Nelson Canada.

**PURPOSE**

To locate an image in a plane mirror.

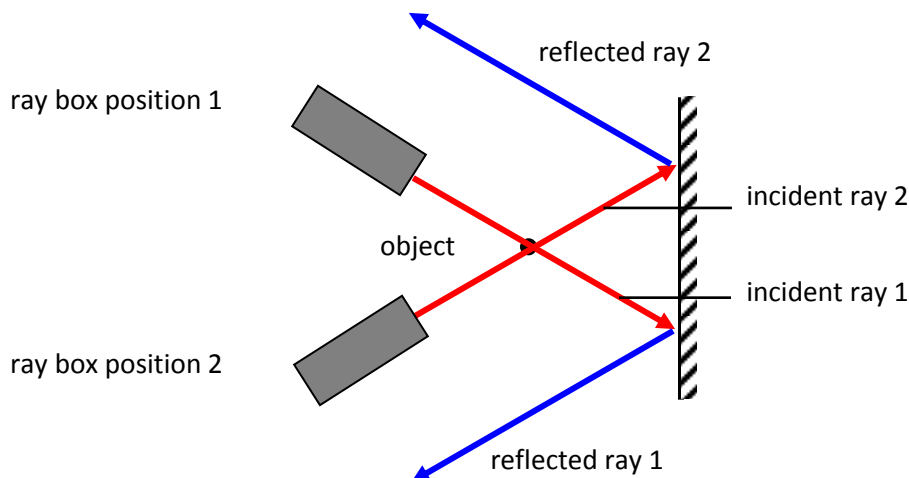
**MATERIALS**

- 1 ray box
- 1 plane mirror with mirror supports
- 1 pen or pencil
- 1 slit mask
- 1 ruler

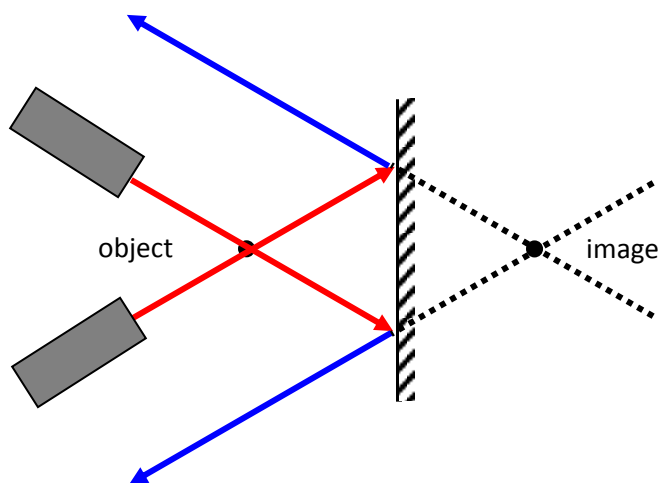


### PROCEDURE: PART A

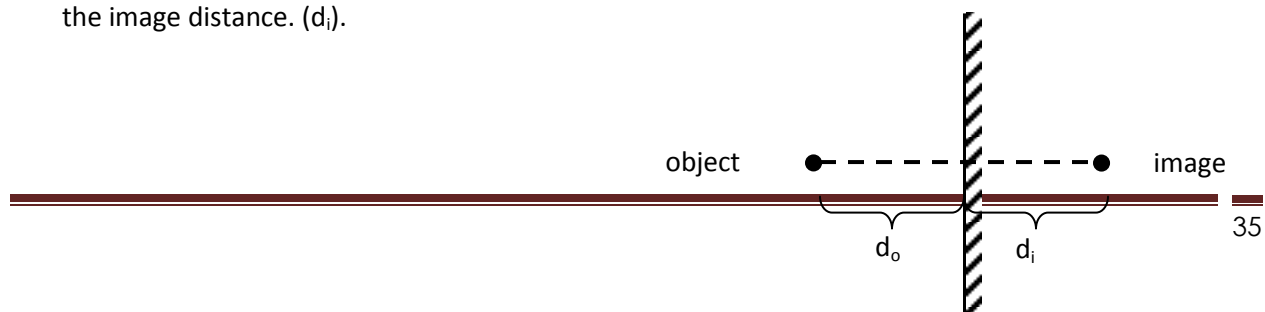
- Place the silvered part of the mirror is on the solid line.
- Get down level with the mirror so you can see image of the dot. Look at the image from several viewpoints.
- Aim an incident ray from the ray box through the dot (object). Trace the incident and reflected rays.
- Move the ray box and aim a second ray through the object. Draw the incident and reflected rays.



- You can now use the rays to explain where the image is located. Use a ruler to draw broken lines extending the reflected rays back behind the mirror. Mark a dot at the point where these extended rays meet. Label this dot **image**.



- On your diagram, the shortest distance mirror to the object. (This is the object distance.) Record the object distance ( $d_o$ ).
- Measure the shortest distance from the mirror to the image. (This is the image distance.) Record the image distance. ( $d_i$ ).



### **PROCEDURE: PART B**

1. Place the silvered part of the mirror is on the solid line.
2. Get down level with the mirror so you can see image of the arrow. Look at the image from several viewpoints.
3. Find and draw two incident and reflected rays from the top of the arrow.
4. Find and draw two incident and reflected rays from the bottom of the arrow.
5. Your diagram should now have 4 incident rays and 4 reflected rays.
6. Remove the mirror and extend the reflected rays back behind the mirror. Find the points marking the top and bottom of the image.
7. Join the top and bottom of the image and label it ***image***.
8. Measure and label the object and image distance. Record your measurements.
9. Measure and label the height of the object and the height of the image. Record your measurements.

### **ANALYZE AND EVALUATE**

- h. How does the image distance compare to the object distance. Did your partners get similar results? [2]
- i. How does the size of the image compare to the size of the object? [1]
- j. Describe how you use light rays to show where an image in a plane mirror is located. [3]

### **APPLY AND EXTEND**

- k. A real image can be seen on a screen. Are the mirror images you worked with in this investigation real or virtual? (You can check your answer. Put a piece of paper where the image seems to be located. If you can see the image on the paper, it is real. If you cannot see the image on the paper, it is virtual.) [1]
- l. State the characteristics (size, attitude, location, type) of the image in a plane mirror. [4]
  - Size: smaller, bigger or same size
  - Attitude: upright, inverted, laterally inverted
  - Location: how far away is the image from the mirror
  - Type: real or virtual

#### **Dot Diagram Marking Scale**

/2	2 incident rays drawn in a solid line
/2	2 reflected rays drawn in a solid line
/2	2 reflected rays extended behind mirror in a dotted line
/3	incident rays, reflected rays and image are labelled

#### **Arrow Diagram Marking Scale**

/2	4 incident rays drawn in a solid line
/2	4 reflected rays drawn in a solid line
/2	4 reflected rays extended behind mirror in a dotted line
/1	image of arrow is drawn in a dotted line
/3	incident rays, reflected rays and image are labelled

## Grade 10 Science, Academic (SNC2D): Light and Geometric Optics

### Lesson 9/Introduction to Refraction

**Duration:** two 75 minute periods

Key Instructional Strategies		Differentiated Instruction Details
1	Word Sort	<b>Knowledge of Students</b> Differentiation based on student: ✓ Readiness <input type="checkbox"/> Interests    ✓ Preferences  <b>Differentiated Instruction Response</b> ✓ Learning materials (content) ✓ Ways of learning (process) <input type="checkbox"/> Ways of demonstrating learning (product) <input type="checkbox"/> Learning environment
2	Generating Hypothesis and Procedure (Generating and Testing Hypotheses)*	
3	Performing Lab	
4	Whole Class Discussion: The Laws of Reflection (Questions and Cues)*	
5	Exit Card (Setting Objectives and Providing Feedback)*	

\*Marzano's Categories of Instructional Strategies    \*\*Differentiated Instruction Structure

### Curriculum Connections

#### Overall Expectation(s):

- A1 demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating)
- E2 investigate, through inquiry, the properties of light, and predict its behaviour, particularly with respect to reflection in plane and curved mirrors and refraction in converging lenses
- E3 demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses.

#### Specific Expectation(s):

- A1.1 formulate scientific questions about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research
- A1.2 select appropriate instruments (e.g., a microscope, laboratory glassware, an optical bench) and materials (e.g., prepared slides, an aquarium, lenses, pH paper) for particular inquiries
- A1.4 apply knowledge and understanding of safe practices and procedures when planning investigations (e.g., appropriate techniques for handling, storing, and disposing of laboratory materials [following the Workplace Hazardous Materials Information System–WHMIS]; safe operation of optical equipment; safe handling and disposal of biological materials), with the aid of appropriate support materials (e.g., the Reference Manual on the WHMIS website; the Live Safe! Work Smart! website)
- A1.5 conduct inquiries, controlling some variables, adapting or extending procedures as required, and using standard equipment and materials safely, accurately, and effectively, to collect observations and data
- A1.6 gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams
- A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty
- A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions
- A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in

<p>electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)</p> <ul style="list-style-type: none"> <li>• A1.12 use appropriate numeric, symbolic, and graphic modes of representation, and appropriate units of measurement (e.g., SI and imperial units)</li> <li>• A1.13 express the results of any calculations involving data accurately and precisely</li> <li>• E2.1 use appropriate terminology related to light and optics, including, but not limited to: angle of incidence, angle of reflection, angle of refraction, focal point, luminescence, magnification, mirage, and virtual image [C]</li> <li>• E2.4 use an inquiry process to investigate the refraction of light as it passes through media of different refractive indices, compile data on their findings, and analyse the data to determine if there is a trend (e.g., the amount by which the angle of refraction changes as the angle of incidence increases varies for media of different refractive indices) [PR, AI, C]</li> <li>• E3.7 identify the factors, in qualitative and quantitative terms, that affect the refraction of light as it passes from one medium to another</li> <li>• E3.8 describe properties of light, and use them to explain naturally occurring optical phenomena (e.g., apparent depth, shimmering, a mirage, a rainbow)</li> </ul>	
<p><b>Catholic Graduate Expectation(s):</b></p> <ul style="list-style-type: none"> <li>• CGE2a: Listens actively and critically to understand and learn in light of gospel values.</li> <li>• CGE3c: Thinks reflectively and creatively to evaluate situations and solve problems.</li> <li>• CGE4a: Demonstrates a confident and positive sense of self and respect for the dignity and welfare of others.</li> <li>• CGE4f: Applies effective communication, decision-making, problem-solving, time and resource management skills.</li> <li>• CGE5a: Works effectively as an interdependent team member.</li> <li>• CGE5b: Thinks critically about the meaning and purpose of work.</li> <li>• CGE5g: Achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others.</li> </ul>	
<p><b>Learning Goal(s):</b></p> <ul style="list-style-type: none"> <li>• Plan an experiment generating a hypothesis and procedure, choosing appropriate equipment and materials.</li> <li>• Determine a relationship (qualitatively or quantitatively) between the angle of incidence and the angle of refraction.</li> </ul>	<p><b>Big Idea(s):</b></p> <ul style="list-style-type: none"> <li>• Light has characteristics and properties that can be manipulated with mirrors and lenses for a range of uses.</li> </ul>

Assessment and Evaluation	
<p><b>Assessment/Success Criteria</b></p> <p><i>Knowledge and Understanding</i></p> <ul style="list-style-type: none"> <li>• knowledge of terminology and definitions (angle of incidence, angle of refraction, normal, etc..) safe use of equipment and materials (ray box, polar coordinate paper, etc...)</li> <li>• understanding of content ( a dense material will cause the refracted ray to bend towards the normal, a less dense material will cause the refracted ray to bend away from the normal, an angle of incidence of zero will result in no refraction)</li> </ul>	<p><b>Assessment Tools</b></p> <ul style="list-style-type: none"> <li>• observations</li> <li>• oral feedback</li> <li>• anecdotal comments</li> <li>• reflection</li> <li>• marking scale</li> </ul>

<p><i>Thinking and Investigation</i></p> <ul style="list-style-type: none"> <li>• use of initiating and planning skills and strategies (developing a hypothesis, planning a procedure, generating a table to record results)</li> <li>• use of processing skills and strategies (performing a lab, recording and gathering data, observing, manipulating materials such as a ray box, polar coordinate paper, semicircular dishes and using equipment safely, solving the ratios <math>\frac{\theta_i}{\theta_R}</math> and <math>\frac{\sin\theta_i}{\sin\theta_R}</math>)</li> <li>• use of critical/creative thinking processes, skills, and strategies (problem solving by planning out an experiment, evaluating the results, forming and justifying conclusions on the basis of evidence)</li> </ul> <p><i>Communication</i></p> <ul style="list-style-type: none"> <li>• expression and organization of information in a table</li> <li>• use of terminology of the discipline in oral, visual, and written forms (angle of refraction, angle of incidence, normal, <math>\theta_i</math>, <math>\theta_R</math>)</li> </ul> <p><i>Application</i></p> <ul style="list-style-type: none"> <li>• application of knowledge and skills (safe use of equipment, scientific investigation skills)</li> </ul>	
<p><b>Prior Learning</b></p> <p>Prior to this lesson, students will have:</p> <ul style="list-style-type: none"> <li>• performed one full lab with the following components: purpose, hypothesis, materials, procedure, observations and results, calculations, error factors, conclusion</li> <li>• an understanding that light travels in straight lines</li> <li>• used a ray box</li> </ul>	
<p><b>Materials and Resources</b></p> <p><b>Materials per group:</b></p> <ul style="list-style-type: none"> <li>• 1 beaker or other transparent container if using Nelson textbook</li> <li>• 1 container with opaque sides if using McGraw-Hill Ryerson textbook</li> <li>• 1 stick</li> <li>• 1 coin</li> <li>• water</li> <li>• 1 ray box</li> <li>• 1 multi-slit slide</li> <li>• 1 polar coordinate paper</li> <li>• 1 semi-circular plexi-glass</li> <li>• 2 semi-circular plastic dishes</li> <li>• different types of media chosen by students (ex. water, oil, honey, etc...)</li> <li>• lab books (can use Hilroy 32 page soft cover notebook)</li> <li>• dish detergent to clean the dishes</li> </ul>	

Appendix 9.1: Word Match

Appendix 9.2: Answers to Word Match and Definitions

Appendix 9.3: Planning a Laboratory Experiment

Appendix 9.4: Questions

Appendix 9.5: Exit Card

**Internet Resources:**

[www.resourcefulphysics.org](http://www.resourcefulphysics.org) (From 31 January 2007, IOP Publishing Limited no longer publishes this website.)

**Resources:**

Adam-Carr, Christine, et al. (2010) Science Perspectives 10. Toronto: Nelson Education Ltd.

Dickinson, Tom et al. (2009) ON Science 10. Toronto, ON: McGraw-Hill Ryerson Limited.

Science 9. Toronto, ON: Nelson Canada, 1995.

Hume, Karen. (2008). Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM). Toronto, ON: Pearson Education Canada.

Institute for Catholic Education. (2003). Ontario Catholic School Graduate Expectations.

Ministry of Education 2008. The Ontario Curriculum, Grades 9 and 10, Science.

Ritter, Bob et al. (1995) Science 9. Scarborough, ON: Nelson Canada.



Grade 10 Science, Academic/SNC2D/ Introduction to Refraction /Lesson #9	
<b>Minds On (Day 1, 75 min)</b> <ul style="list-style-type: none"> <li>♦ Establishing a positive learning environment</li> <li>♦ Connecting to prior learning and/or experiences</li> <li>♦ Setting the context for learning</li> </ul>	<b>Connections</b> L: Literacy ML: Mathematical Literacy AfL: Assessment <b>for</b> Learning AaL: Assessment <b>as</b> Learning AoL: Assessment <b>of</b> Learning DI: Differentiated Instruction EE: Environmental Education
<p><b>Small Groups ⇒ What do you Think?</b>  Students answer “What do you Think?” questions on pg 513 in Nelson’s Science Perspectives 10.</p> <p><b>Small Groups ⇒ Try This</b>  Students perform “Try This” activity on pg 515 in Nelson’s Science Perspectives 10.  OR  Students perform Activity 11-1 on pg 447 in McGraw Hill- Ryerson ON Science 10.</p> <p><b>Whole Class ⇒ Teacher Demo</b>  Demonstrate refraction of light through semicircular plexi-glass.  Review the correct use of a ray box and polar coordinate paper.</p> <p><b>Small Groups ⇒ Diagram Word Matching</b>  Provide each group with a diagram and a set of words (Appendix 9.1).  Students <ul style="list-style-type: none"> <li>• cut out the words and label the diagram</li> <li>• brainstorm definitions for each new word (may use textbook)</li> <li>• reflection terms have already been defined in lesson 4</li> </ul> <p>Consider using a cooperative learning strategy such as “two stay one strays” to generate more discussion and to compare diagrams and definitions.</p> <p>Circulate and provide feedback when necessary.  Reveal the answer key after all groups are satisfied with their diagrams.  Refer to Appendix 9.2 for definitions and a labeled diagram.</p> <p>Share and discuss the learning goals.</p> <p><b>Small Groups ⇒ Planning the Experiment</b>  The purpose of the experiment is to explore the path of light as it travels from one medium into another.  Students will plan out their experiment by <ul style="list-style-type: none"> <li>• choosing 2 mediums (one medium may be air)</li> <li>• choosing the equipment</li> <li>• determining what they will measure and how</li> <li>• choosing the method they will use to record their observations</li> </ul> </p> </p>	<p>AfL: Observations/Oral Feedback</p> <p>AfL: Sharing and discussing learning goals</p>

<p>You may choose to provide them with Appendix 9.3 to help them plan their experiment. They may also refer to their textbook for ideas. They may bring materials from home.</p> <p>Circulate and provide feedback when necessary. Ensure all groups have planned out an experiment that will be successful before they leave so that the experiment may be conducted during the following class. Make sure they plan to record at least seven different angles of incidence with their corresponding angles of refraction.</p> <p>Consider using a lab book for students to plan out their experiment and record their results.</p>	<p>AfL: Observations/Oral Feedback</p>
<p><b>Action (Day 2, 45 min)</b></p> <ul style="list-style-type: none"> <li>♦ Introducing new learning or extending/reinforcing prior learning</li> <li>♦ Providing opportunities for practice and application of learning (guided → independent)</li> </ul>	
<p><b>Small Groups ⇒ Performing Lab</b></p> <p>Have students perform the lab they planned out the day before.</p> <p>Circulate and provide feedback when necessary.</p> <p><b>Individuals or Small Groups⇒ Analyze and Evaluate Questions</b></p> <p>Students complete the <i>Analyze and Evaluate Questions</i>. (Appendix 9.4)</p> <p>Consider evaluating the questions using the marking scale provided on the handout.</p> <p>You may also choose to have students write-up a formal lab report which you can evaluate.</p>	<p>AfL: Observations/Oral Feedback</p> <p>L: Literacy</p> <p>ML: Mathematical Literacy</p> <p>AoL: Marking Scale</p>
<p><b>Consolidation and Connection (Day 2, 30 min)</b></p> <ul style="list-style-type: none"> <li>♦ Helping students demonstrate what they have learned</li> <li>♦ Providing opportunities for consolidation and reflection</li> </ul>	
<p><b>Whole Class ⇒ Refraction Through Different Media Discussion</b></p> <p>Facilitate a discussion to help consolidate learning and summarize their observations.</p> <p><b>Individuals ⇒ Exit Card</b></p> <p>Individually, students reflect on their learning and complete an exit card (Appendix 9.5).</p> <p>Allow students to write their reflections onto post-it notes and stick them onto a larger version of the exit card.</p> <p>Use the exit card to assess the learning goals and to guide further instruction.</p>	<p>AaL/AfL: Exit Card</p>

### Whole Class ⇒ Extension Activity - Marching Soldiers Activity

This activity helps students visualize why light bends when it enters a new medium.

Divide class into four groups.

Group 1 represents a wave front travelling from less dense to more dense and approaches the boundary with an angle greater than  $0^\circ$ .

Group 2 represents a wave front travelling from more dense to less dense and approaches the boundary with an angle greater than  $0^\circ$ .

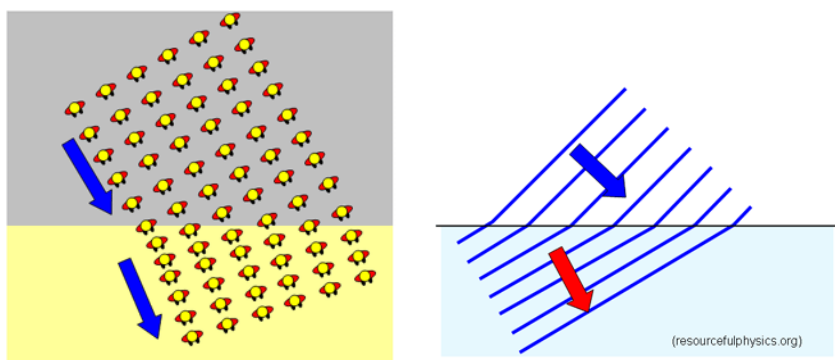
Group 3 represents a wave front travelling from less dense to more dense and approaches the boundary with an angle of  $0^\circ$  (along the normal).

Group 4 represents a wave front travelling from more dense to less dense and approaches the boundary with an angle of  $0^\circ$  (along the normal).

Using masking tape, create a boundary and a normal.

Place the group 1 students side by side in a straight line (as shown below). Have the students hold metre sticks between each other to form a straight wave front. This will help them walk as one unit. They are to walk fast (as one unit) until they reach the boundary. As soon as they reach the boundary they must slow down. Since each student reaches the boundary at a different time, the wave front will change direction.

You may choose to let the middle student hold a metre stick pointing forward to represent the ray of light. You may then ask the class what they observed; did the ray of light move towards or away from the normal.



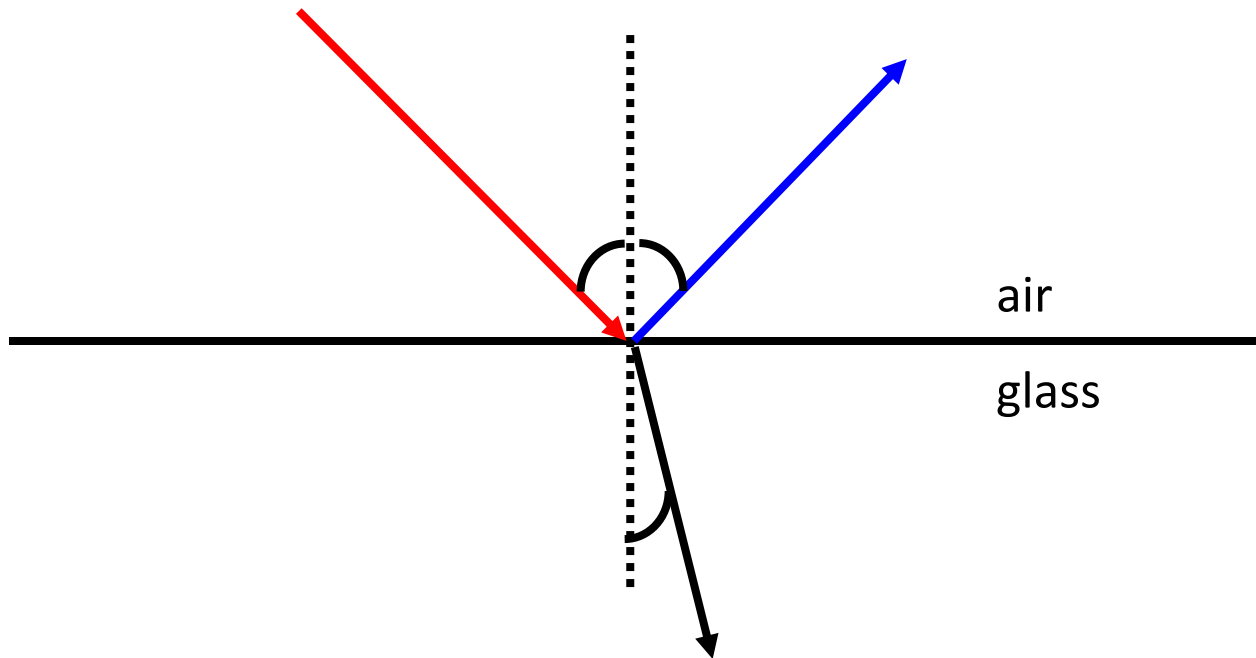
source: <http://resourcefulphysics.org/> (website is no longer available)

Repeat with Group 2 but now the students walk slow until they reach the boundary and speed up after they cross the boundary. Once again, each student reaches the boundary at a different time and the ray will change direction.

Repeat with Groups 3 and 4. Since they are travelling with the ray of light lined up along the normal, they will change speed but their direction will remain the same.

**Word Match**

Cut out the words below and place them correctly onto the diagram. Generate definitions for the following words: refraction, angle of refraction, refracted ray.



angle of incidence	incident ray	mirror
angle of reflection	reflected ray	refracted ray
$\theta_i$	point of incidence	$\theta_r$
angle of refraction	normal	$\theta_R$

**Answers to Word Match and Definitions****refraction**

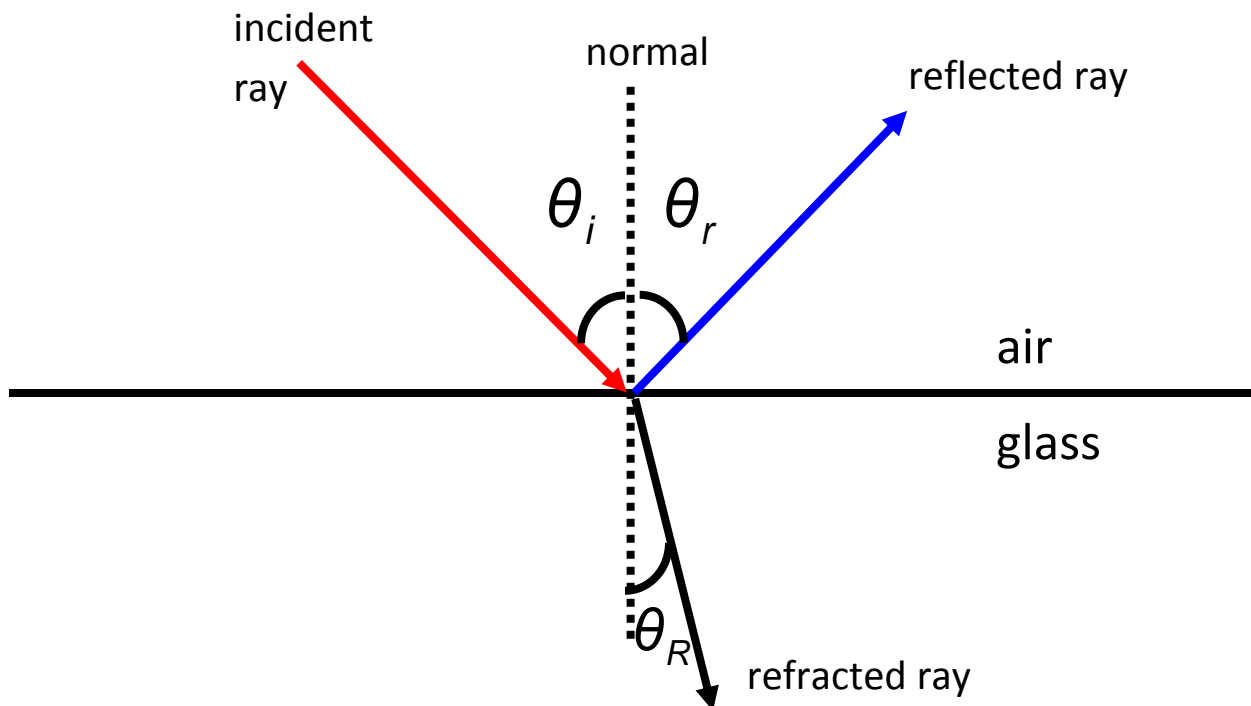
Refraction is the change in direction of light as it moves from one medium to another. (*“bending of light”*)

**refracted ray**

The ray of light that changes direction at the boundary as it travels from one medium into another.

**angle of refraction ( $\theta_R$ )**

The angle between the refracted ray and the normal.



## Planning a Laboratory Experiment

### Purpose

The purpose of this experiment is to explore the path of light as it travels from one medium to another and compare the angle of incidence to the angle of refraction.

### Hypothesis

Using the knowledge that you have acquired in class, how do you think the angle of incidence will compare to the angle of refraction?

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### Equipment and Materials

Generate a list of the equipment and materials you will need.

<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

Draw a diagram on the equipment set-up you plan to use below.



Figure 1 – Experimental Set-Up for the Refraction of Light

## Procedure

Use the following questions to help you generate a procedure:

What are the variables in the problem?

What factors should be kept constant to ensure a fair test?

How will you measure the angles of incidence and refraction?

This image shows a full page of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page, providing a template for handwriting practice or general writing. There are no margins, text, or other markings on the page.

## **Results**

Use the space below to create two tables that you will use to record your results.

You must choose at least seven different angles of incidence and record the corresponding angle of refraction.

One of the angles of incidence must be  $0^\circ$ .

You need two tables because you should first direct the ray of light from less dense to more dense followed by more dense to less dense.



## Questions

### Analyze and Evaluate

#### Ray of Light Traveling from a Less Dense Medium to a Denser Medium

1. What was the angle of refraction when the angle of incidence was  $0^\circ$ ? [1 mark]
2. How did the value of the angle in the less dense medium compare to the angle in the denser medium? [1 mark]
3. Which way did the refracted ray bend in the denser medium compared to the normal? [1 mark]
4. What trend do you notice in the angle of the refracted ray as the angle of incidence in the less dense medium increases? [1 mark]

#### Ray of Light Traveling from a Denser Medium to a Less Dense Medium

5. Which way did the refracted ray bend in the less dense medium compared to the normal? [1 mark]
6. What trend do you notice in the angle of the refracted ray as the angle of incidence in the denser medium increases? [1 mark]

### Apply and Extend

7. Some students may have used a semi-circular plastic dish to hold their chosen medium. What is the advantage of using the semi-circular dish? [2 marks]
8. Add the following columns to your Results Tables:  $\frac{\theta_i}{\theta_R}$ ,  $\sin\theta_i$ ,  $\sin\theta_R$ ,  $\frac{\sin\theta_i}{\sin\theta_R}$ . Complete the tables by calculating those values. [4 marks]
9. With the exception of  $\theta_i = 0^\circ$ , what do you notice about the ratio of  $\frac{\theta_i}{\theta_R}$ . [2 marks]
10. With the exception of  $\theta_i = 0^\circ$ , what do you notice about the ratio of  $\frac{\sin\theta_i}{\sin\theta_R}$ . [2 marks]
11. Why were you not able to calculate the ratio of  $\frac{\theta_i}{\theta_R}$  or  $\frac{\sin\theta_i}{\sin\theta_R}$  for an angle of incidence of  $0^\circ$ ? [1 mark]
12. Which ratio  $\frac{\theta_i}{\theta_R}$  or  $\frac{\sin\theta_i}{\sin\theta_R}$  is nearly constant? [1 mark]
13. Determine the indices of refraction for the medium you have used. Can you make a connection between the indices and the ratios that you calculated? [optional]

**source:** Adam-Carr, Christine, et al. (2010) Science Perspectives 10. Toronto: Nelson Education Ltd.

## ANSWERS

### Ray of Light Traveling from a Less Dense Medium to a Denser Medium

1. The angle of refraction was  $0^\circ$ .
2. The angle of refraction in the less dense medium was larger.
3. The refracted ray bent toward the normal.
4. The angle of refraction also increases.

### Ray of Light Traveling from a Denser Medium to a Less Dense Medium

5. The refracted ray bent away from the normal.
6. The angle of refraction also increases.

## Apply and Extend

7. There is no refraction along the curved surface.
8. refer to student tables
9. There appears to be no trend.
10. The ratio of  $\frac{\sin\theta_i}{\sin\theta_R}$  is nearly constant.
11. No, dividing by zero results in an undefined answer.
12. The ratio of  $\frac{\sin\theta_i}{\sin\theta_R}$  is nearly constant.
13. The ratio of  $\frac{\sin\theta_i}{\sin\theta_R}$  should be equal to  $\frac{n_R}{n_i}$ .

## Exit Card



**3** things I learned today

•  
•  
•

**2** questions I still have

•  
•

**1** connection I can make

•



Clear	Unclear



source: Hume, Karen. (2008). Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM). Toronto, ON: Pearson Education Canada (Exit Cards —Black Line Master 10.5)

## Grade 10 Science, Academic (SNC2D): Light and Geometric Optics

### Lesson 18/Applications of Mirrors and Lenses

**Duration:** two 75 minute periods

Key Instructional Strategies		Differentiated Instruction Details
1	Optical Devices Placemat (Cooperative Learning)*	<b>Knowledge of Students</b> Differentiation based on student: ✓ Readiness    ✓ Interests    ✓ Preferences  <b>Differentiated Instruction Response</b> ✓ Learning materials (content) <input type="checkbox"/> Ways of learning (process) ✓ Ways of demonstrating learning (product) <input type="checkbox"/> Learning environment
2	Learning Stations**	
3	Exit Card (Setting Objectives and Providing Feedback)*	

\*Marzano's Categories of Instructional Strategies    \*\*Differentiated Instruction Structure

### Curriculum Connections

#### Overall Expectation(s):

- E1. evaluate the effectiveness of technological devices and procedures designed to make use of light, and assess their social benefits
- E3. demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses.

#### Specific Expectation(s):

- E1.2 analyse a technological device that uses the properties of light (e.g., microscope, retroreflector, solar oven, camera), and explain how it has enhanced society [AI, C]
- E2.1 use appropriate terminology related to light and optics, including, but not limited to: angle of incidence, angle of reflection, angle of refraction, focal point, luminescence, magnification, mirage, and virtual image [C]
- E3.6 identify ways in which the properties of mirrors and lenses (both converging and diverging) determine their use in optical instruments (e.g., cameras, telescopes, binoculars, microscopes)

#### Catholic Graduate Expectation(s):

- CGE2b: Reads, understands and uses written materials effectively.
- CGE2e: Uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.
- CGE4e: Sets appropriate goals and priorities in school, work and personal life.
- CGE4f: Applies effective communication, decision-making, problem-solving, time and resource management skills.
- CGE5a: Works effectively as an interdependent team member.
- CGE5b: Thinks critically about the meaning and purpose of work.
- CGE5g: Achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others.

<b>Learning Goal(s):</b> <ul style="list-style-type: none"> <li>Analyse a technological device that uses the properties of light (e.g., microscope, retroreflector, solar oven, camera), and explain how it has enhanced society</li> <li>Communicate clearly in chosen format and use terminology appropriately.</li> </ul>	<b>Big Idea(s):</b> <ul style="list-style-type: none"> <li>Light has characteristics and properties that can be manipulated with mirrors and lenses for a range of uses.</li> <li>Society has benefited from the development of a range of optical devices and technologies.</li> </ul>
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Assessment and Evaluation	
<b>Assessment/Success Criteria</b> <i>Communication</i> <ul style="list-style-type: none"> <li>Expresses and organizes ideas and information clearly in chosen format.</li> <li>Uses scientific terminology appropriately.</li> </ul> <i>Application</i> <ul style="list-style-type: none"> <li>Transfers knowledge of light, mirrors and/or lenses to unfamiliar contexts</li> <li>Makes connections by evaluating the effectiveness of a technological device on people and our society</li> </ul>	<b>Assessment Tools</b> <ul style="list-style-type: none"> <li>observations</li> <li>oral feedback</li> <li>anecdotal comments</li> <li>rubric</li> </ul>

Prior Learning
Prior to this lesson, students will have: <ul style="list-style-type: none"> <li>Completed the optics unit and learned about mirrors, lenses, reflection, refraction, etc...</li> </ul>

Materials and Resources
<b>Materials:</b> access to computers and internet 1 toolbox as many of the following devices as possible: <ul style="list-style-type: none"> <li>retroreflector</li> <li>optical fibres (focus on benefits in telecommunication)</li> <li>optical fibres (focus on benefits in medicine)</li> <li>solar oven</li> <li>digital camera</li> <li>film camera</li> <li>microscope</li> <li>rearview mirror</li> <li>reflecting telescope</li> <li>refracting telescope</li> <li>binoculars</li> </ul> Appendix 18.1: Sample Placemat Appendix 18.2: Exit Card

**Resources:**

Adam-Carr, Christine, et al. (2010) Science Perspectives 10. Toronto: Nelson Education Ltd.

Dickinson, Tom et al. (2009) ON Science 10. Toronto, ON: McGraw-Hill Ryerson Limited.

Science 9. Toronto, ON: Nelson Canada, 1995.

Hume, Karen. (2008). Start Where They Are: Differentiating for Success with the Young Adolescent (with CD-ROM). Toronto, ON: Pearson Education Canada.

Institute for Catholic Education. (2003). Ontario Catholic School Graduate Expectations.

Ministry of Education 2008. The Ontario Curriculum, Grades 9 and 10, Science.

Ritter, Bob et al. (1995) Science 9. Scarborough, ON: Nelson Canada.

## Grade 10 Science, Academic/SNC2D/Analyzing Optical Devices/Lesson # 18

### Minds On (Day 1, 30 min)

- ♦ Establishing a positive learning environment
- ♦ Connecting to prior learning and/or experiences
- ♦ Setting the context for learning

### Connections

L: Literacy  
ML: Mathematical Literacy  
AfL: Assessment **for** Learning  
AaL: Assessment **as** Learning  
AoL: Assessment **of** Learning  
DI: Differentiated Instruction  
EE: Environmental Education

### Groups of 4 ⇒ Optical Devices Placemat

- Distribute a piece of chart paper to each group.
- Ask students to divide the chart paper into four sections leaving a square in the centre (see Appendix 18.1 for a sample placemat).
- Provide each group with a different optical device (e.g. microscope, rearview mirror, camera, telescope, binoculars, retroreflector, solar oven, optical fibres, etc.) Consider providing a diagram if a device is not available.
- Individually, students think about the following questions:
  - What do you think the device is used for?
  - How do you think it works? Does it use mirrors or lenses?
  - Do you think it has any benefit to society? How?
 and then write their ideas silently in one box of the chart paper.
- Signal students in each group to discuss their ideas and find the common elements. Students record the common elements in the middle square.
- Circulate and provide feedback when necessary.

### Whole Class ⇒ Optical Devices Placemat Discussion

- Students post the placemats and share their group's thinking with the class.
- Use the placemats to pre-assess student prior knowledge of optical devices and to introduce the importance of investigating and understanding the properties of light, mirrors and lenses.

Share and discuss the learning goals.

AfL: Observations/Oral Feedback

AfL: Sharing and discussing learning goals

**Action (Day 1, 45 min + Day 2, 30 min)**

- ♦ Introducing new learning or extending/reinforcing prior learning
- ♦ Providing opportunities for practice and application of learning (guided → independent)

**Groups of 3 ⇒ Analyzing Optical Devices (Learning Centres)**

Divide your classroom into 3 different stations. Assign the groups to a station. At each station, students must answer the following three questions:

- What do you think the device is used for?
- How do you think it works? Does it use mirrors or lenses?
- Do you think it has any benefit to society? How?

Each group is assigned or chooses three devices to analyze from the following list:

- retroreflector
- optical fibres (focus on benefits in telecommunication)
- optical fibres (focus on benefits in medicine)
- solar oven
- digital camera
- film camera
- microscope
- rearview mirror
- reflecting telescope
- refracting telescope
- binoculars

Ensure that each device is analyzed by students at Station 1 and Station 2, not all devices will be able to be analyzed at Station 3.

**Station 1 – Textbook Research**

Groups assigned to Station 1 will search in their textbooks for answers to the questions.

**Station 2 – Website Research**

Groups assigned to Station 2 will search the internet for answers to the questions.

retroreflector:

<http://www.physics.ucsd.edu/~tmurphy/apollo/lrrr.html>

fibre optics:

<http://videos.howstuffworks.com/university-of-bath/1657-photonics-gives-a-new-way-of-controlling-light-video.htm>

binoculars:

[http://www.birdwatching.com/optics/how\\_binoculars\\_work.html](http://www.birdwatching.com/optics/how_binoculars_work.html)

solar oven:

<http://www.howstuffworks.com/environmental/green-science/solar-cooking.htm>

digital camera:

DI: Learning Centres/  
Learning Preferences

AfL: Circulate, Make  
Observations/Anecdotal  
Comments



<p> <a href="http://electronics.howstuffworks.com/cameras-photography/digital/digital-camera.htm">http://electronics.howstuffworks.com/cameras-photography/digital/digital-camera.htm</a>  film camera:  <a href="http://electronics.howstuffworks.com/camera.htm">http://electronics.howstuffworks.com/camera.htm</a>  microscopes:  <a href="http://www.howstuffworks.com/light-microscope.htm">http://www.howstuffworks.com/light-microscope.htm</a>  rearview mirror:  <a href="http://justinketterer.com/2010/04/29/rear-view-mirror-dimmer/">http://justinketterer.com/2010/04/29/rear-view-mirror-dimmer/</a>  reflecting and refracting telescopes:  <a href="http://www.howstuffworks.com/telescope.htm">http://www.howstuffworks.com/telescope.htm</a> </p> <p> Station 3 – Taking Optical Device Apart  Groups assigned to Station 3 will take apart the devices and put them back together in order to answer the questions. Try to find as many devices from the list that students can take apart. </p> <p> Each group will be presenting their findings on the following day. Allow them to choose their presentation format (ex. chart paper, showing the website they accessed, drawing on the blackboard, etc...) </p>	
<b>Consolidation and Connection (Day 2, 45 min)</b> <ul style="list-style-type: none"> <li>♦ Helping students demonstrate what they have learned</li> <li>♦ Providing opportunities for consolidation and reflection</li> </ul>	
<p><b>Whole Class ⇒ Discussion</b></p> <ul style="list-style-type: none"> <li>• Groups share their observations, results and conclusions</li> <li>• Guide students to use their results to summarize the ... theory/law/property</li> <li>• Refer back to the optical devices and pose the question: Which devices use this property? How?</li> <li>• Students reflect and brainstorm answers to the question</li> </ul> <p><b>Individual ⇒ Exit Card</b></p> <ul style="list-style-type: none"> <li>• Students complete an exit card (Appendix 3.2) to reflect on their lab experience</li> <li>• Consider using the exit card to assess the learning goals and to guide further instruction</li> </ul>	<p>AaL/AfL: Exit Card</p>

**Sample Placemat**

<p>Write quietly on your own in your section of the border for several minutes.</p>	
	<p>Through group sharing of ideas and experiences, gather common concerns, concepts, and ideas in this section of the place mat.</p>

(Source: *Think Literacy: Cross-Curricular Approaches, Grades 7-12*)

**Exit Card**

**3** things I learned today

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.

.

**2** questions I still have

.

.

**1** connection I can make

.



Draw an illustration or make a graphic organizer of today's lesson.



(source: Start Where They Are: Differentiating for Success with the Young Adolescent)